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DOE Contract No. DE-AC05-03OR22980
Job No. 23900
LTR-PAD/EP-DH-03-0133
October 23, 2003

Mr. William E. Murphie, Manager
Portsmouth/Paducah Project Office
U.S. Department of Energy
P.O. Box 1410
Paducah, KY 42002-1410

Dear Mr. Murphie:

DE-AC05-03OR22980: Transmittal—*Site Investigation Work Plan for the Southwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (DOE/OR/07-2094&D1) Secondary Document; *Quality Assurance Project Plan for the Southwest Plume Site Investigation at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC/PAD-588); *Data Management Implementation Plan for the Southwest Plume Site Investigation at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC/PAD-589); *Waste Management Plan for the Southwest Plume Site Investigation at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC/PAD-590); and *Environmental, Safety, and Health Plan for the Southwest Plume Site Investigation at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky* (BJC/PAD-591)

Enclosed are 18 copies of each of the subject documents. The documents include the sampling and analysis plan and companion documents—the quality assurance project plan, the data management implementation plan, the waste management plan, and the environmental, safety, and health plan. The project is an assessment of the configuration of potential contaminant sources for the Southwest Plume.

A suggested-text letter is being provided for transmittting 11 sets of copies to the following at the state regulatory agencies: Ms. Gaye Brewer, Mr. Robert Daniell (seven), Mr. Steve Hampson, Mrs. Janet Miller, and Mr. Eric Scott. Four copies are to be transmitted to Mr. Carl Froede at the U.S. Environmental Protection Agency. Three copies of each document are for your use. The remaining distribution is being made in accordance with the *Standard Distribution List for Bechtel Jacobs Company LLC Primary and Secondary Documents (July 29, 2003).* Please provide your comments electronically to Larry Young at ly3@bechteljacobs.org no later than December 1, 2003.

If you have any questions or need additional information, please contact Larry Young of my staff at (270) 441-5187.

Sincerely,

Gordon L. Dover
Paducah Manager of Projects

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DOE/OR/07-2094&D1
Secondary Document

Site Investigation Work Plan for the Southwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

I-04609-0002

This document is approved for public release per review by:

10/16/03
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contributed to the preparation of this document and should not be considered an eligible contractor for its review.

CERTIFICATION

Document Identification: ***Site Investigation Work Plan for the Southwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky*** **(DOE/OR/07-2094&D1) Secondary Document**

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

U.S. Department of Energy (DOE)
Owner and Operator

Gregory A. Bazzell

for William E. Murphie, Manager
Portsmouth/Paducah Project Office

10/23/03
Date Signed

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Bechtel Jacobs Company LLC
Co-operator

Gordon L. Dover, Paducah Manager of Projects

10/23/03
Date Signed

DOE/OR/07-2094&D1
Secondary Document

Site Investigation Work Plan for the Southwest Plume at the Paducah Gaseous Diffusion Plant, Paducah, Kentucky

Date Issued—October 2003

Prepared for the
U.S. DEPARTMENT OF ENERGY
Office of Environmental Management

by
Bechtel Jacobs Company LLC
managing the

Environmental Management Activities at the
Paducah Gaseous Diffusion Plant
Paducah, Kentucky 42001
for the
U.S. DEPARTMENT OF ENERGY
under contract DE-AC05-03OR22980

101503

CONTENTS

FIGURES

TABLES

ABBREVIATIONS AND ACRONYMS

bgs	below ground surface
CFR	*Code of Federal Regulations*
COC	chain-of-custody
DCE	dichloroethene
DNAPL	dense nonaqueous-phase liquid
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
DPT	Direct Push Technology
DSITMS	direct sampling ion-trap mass spectrometer
DWRC	dual-wall reverse circulation
Eh	oxidation reduction potential
EPA	U.S. Environmental Protection Agency
ES&HP	Environmental, Safety, and Health Plan
GC/MS	gas chromatograph/mass spectrometer
HSA	hollow stem auger
IDW	investigation-derived waste
MCL	maximum contaminant level
MIP	Membrane Interface Probe
MW	monitoring well
Paducah OREIS	Paducah's Oak Ridge Environmental Information System
Paducah PEMS	Paducah's Project Environmental Measurements System
PCB	polychlorinated biphenyl
PGDP	Paducah Gaseous Diffusion Plant
pH	negative logarithm of the hydrogen-ion concentration
PID	photoionization detector
PPE	personal protective equipment
PTZ	Permeable Treatment Zone
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
RA	Remedial Action
Rad	Total uranium (U), ^{234}U, ^{235}U, ^{238}U, neptunium-237, plutonium-239, ^{99}Tc, Gross Alpha, and Gross Beta
RGA	Regional Gravel Aquifer
RI	Remedial Investigation
SI	Site Investigation
SMO	Sample Management Office
SWMU	solid waste management unit
TCA	trichloroethane
^{99}Tc	technetium-99
TCE	trichloroethene
U	uranium
VOC	volatile organic compound
VC	vinyl chloride
WAG	waste area group
WMP	Waste Management Plan

EXECUTIVE SUMMARY

The Southwest Plume refers to an area of groundwater contamination at the Paducah Gaseous Diffusion Plant in the Regional Gravel Aquifer (RGA) that is found south of the Northwest Plume and west of the C-400 Building. The plume was first identified during the Waste Area Grouping 27 Remedial Investigation in 1998. Additional work to characterize the plume was performed as part of the Data Gaps Investigation in 1999. The primary contaminants are trichloroethene with lesser amounts of other volatile organic compounds (VOCs) and the radionuclide, technetium-99 (^{99}Tc). This Site Investigation (SI) Work Plan presents the basic strategies and procedures that will apply to fieldwork, soil sampling, and groundwater sampling conducted as part of the Southwest Plume SI.

This SI will focus on four potential source areas of contamination to the Southwest Plume and will profile the current level and distribution of VOCs and ^{99}Tc in the dissolved phase plume along the western fence of the plant secured area. The four potential source areas being investigated are

- the C-747-A Oil Landfarm (Solid Waste Management Unit [SWMU] 001),
- the C-720 Building, specifically areas near the northeast and southeast corners,
- the storm sewer between the south side of the C-400 Building and Outfall 008 (SWMU 102), and
- the C-747 Contaminated Burial Yard (SWMU 004).

Three of the four source areas and the dissolved phase plume have been addressed in previous investigations. The storm sewer has not been investigated as a potential source of groundwater contamination. In broad terms, the primary focus of the sampling strategy will be to collect sufficient data to resolve data gaps for each of the units.

At SWMU 001, the C-720 area, and along the storm sewer, VOC contamination in the shallow soils of the upper continental deposits will be profiled using direct push technology combined with a membrane interface probe. Discrete depth soil samples will be collected and sent to a lab for VOC, metals, and radionuclide analysis. Temporary borings will be used to collect discrete depth groundwater samples from the RGA at SWMU 004 and in the dissolved phase plume. These samples will be analyzed for VOC and ^{99}Tc contamination. Existing RGA monitoring wells (MWs) within the area of the plume will be sampled for VOCs, metals, and radionuclides. Finally, up to four MWs may be installed to monitor the migration of contamination within the plume.

1. PROJECT DESCRIPTION

This Site Investigation (SI) Work Plan presents the basic strategies and procedures that will apply to fieldwork, soil sampling, and groundwater sampling conducted as part of the Southwest Plume SI. The following is the problem statement for this investigation.

Hazardous substances, primarily volatile organic compounds (VOCs) and technetium-99 (^{99}Tc), have been detected above the maximum concentration limit in groundwater monitoring wells (MWs) west of the C-400 Building and south of the groundwater contamination area identified as the Northwest Plume. Several solid waste management units (SWMUs) overlie the area of groundwater contamination, which has been named the Southwest Plume. As a result of past investigations, some of these SWMUs have been identified as potential sources of groundwater contamination. It is unknown if or how much of the detected hazardous substances are migrating from these units or if the substances are originating from upgradient sources.

This investigation will focus on four potential source areas of contamination to the Southwest Plume and will profile the current level and distribution of VOCs and ^{99}Tc in the dissolved phase plume along the western fence of the plant secured area. The four potential source areas being investigated are

- the C-747-A Oil Landfarm (SWMU 001),
- the C-720 Building, specifically areas near the northeast and southeast corners,
- the storm sewer between the south side of the C-400 Building and Outfall 008 (SWMU 102), and
- the C-747 Contaminated Burial Yard (SWMU 004).

Three of the four source areas and the dissolved phase plume have been addressed in previous investigations. The storm sewer has not been investigated as a potential source of groundwater contamination. In broad terms, the primary focus of the sampling strategy will be to collect sufficient data to answer outstanding questions about each of the units. Section 2.3 of this SI Work Plan provides a discussion of each unit, the questions to be answered, and the methods to be used to answer the questions.

The Southwest Plume SI will be conducted within the U.S. Department of Energy (DOE)-secured area of the Paducah Gaseous Diffusion Plant (PGDP). The area of investigation is bounded on the east by 10^{th} Street, on the south by the plant security fence immediately south of the C-720 Building, on the west by the west plant security fence, and on the north by Texas Avenue. Figure 1 shows the study area relative to the Trichloroethene (TCE) plume, while Fig. 2 shows the study area and the underlying ^{99}Tc plume. Vertically, the investigation will focus on the soils of the upper continental deposits (surface to approximately 50 ft below ground surface [bgs]) and on groundwater in the Regional Gravel Aquifer (RGA), generally between 50 and 100 ft bgs. Temporary borings and existing groundwater MWs will be used to collect the information needed to answer the study questions for each unit. The analytes of interest vary from unit to unit and depend on the medium being sampled, but, in general, consist of VOCs, metals, and radionuclides

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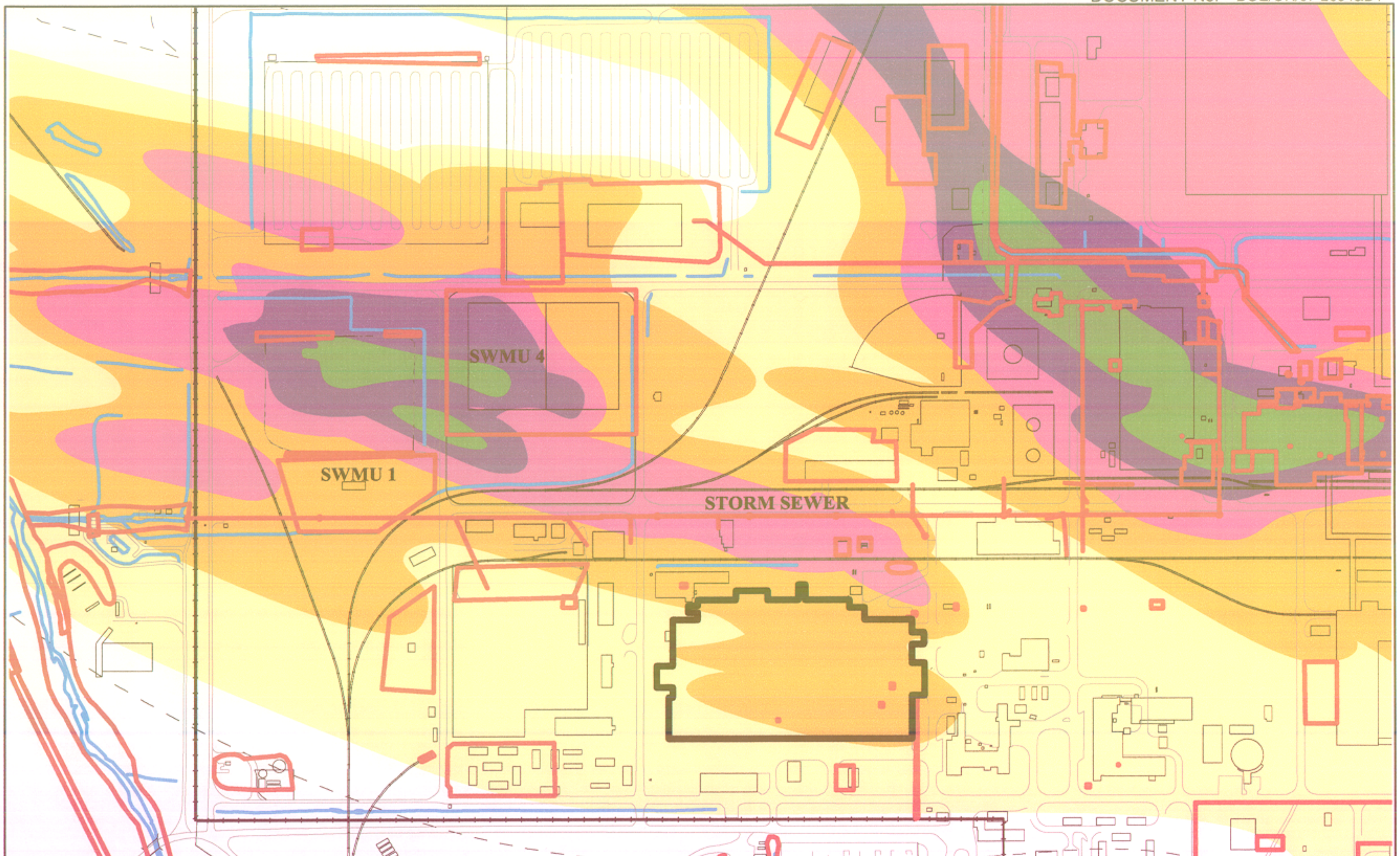

LEGEND
SWMU
ROAD
SURFACE WATER

INTERPRETED
2002 TCE PLUME (ug/L)
100,000
10,000
1000
100
5
1

500 0 500 Feet

TRUE NORTH
PLANT NORTH
20

U.S. DEPARTMENT OF ENERGY
DOE OAK RIDGE OPERATIONS
PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS
BECHTEL JACOBS COMPANY LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER
US GOVERNMENT CONTRACT DE-AC05-03OR22980
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

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Fig. 1. Southwest Plume Investigation area and TCE Plume.

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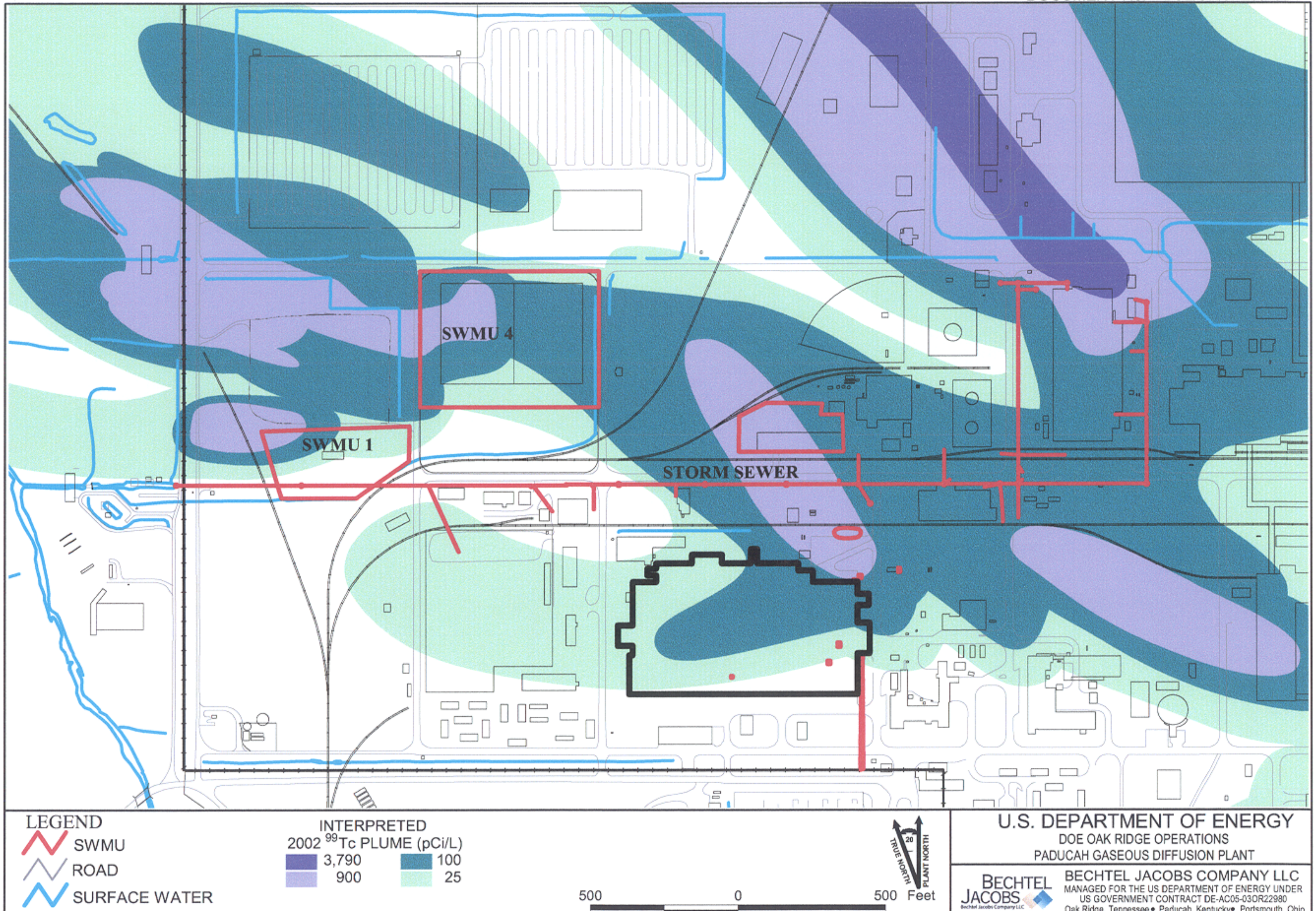

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Fig. 2. Southwest Plume Investigation area and ^{99}Tc Plume.

FIGURE No. c5ac90001sk652r2.apr
DATE 09-22-03

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2. SAMPLING AND ANALYSIS PLAN

2.1 SAMPLING MEDIA AND METHODS

This investigation will perform a video survey of a storm sewer and sample soils for lithologic description and contaminant analysis, groundwater for contaminant analysis, the work environment for the health and safety of the project crews, and investigation-derived waste (IDW) for waste characterization prior to final disposition. This section identifies the different media to be sampled during the investigation and suggests methods for collecting the samples. Section 2.3 "Site-Specific Sampling Plans" discusses the sampling strategy in detail. Section 2.4 "Fieldwork and Sampling Methods and Procedures" describes drilling and abandonment methods and requirements as well as activities requiring formal procedures or work instructions.

2.1.1 Utility Survey

Prior to final location of the borings along the storm sewer from the C-400 area west to Outfall 008, the storm sewer will be inspected for holes and cracks that could serve as exit pathways for contaminants that may have been carried by the storm sewer. Video systems for inspecting underground utilities are a relatively common and proven technology. They utilize a remotely operated video camera, a mechanism for moving the camera through the pipe, and a video recorder on the surface.

2.1.2 Soils

Soil samples will be collected using DPT from the upper continental deposits at the C-747-A Oil Landfarm, the C-720 area, and along the storm sewer from the C-400 area for lithologic description and for contaminant analysis. In the RGA, soil samples will be collected for lithologic description only.

2.1.2.1 Lithologic Description

The description of the physical appearance of the soils being sampled is a basic piece of information acquired with each new boring. Depth, color, grain size, and texture help develop a three-dimensional picture of the subsurface sediments. Several methods are available for collecting samples for description, each dependent on the drilling method being used.

DPT has become a standard method for collecting soil and groundwater samples from shallow sediments. Simply, a vehicle-mounted hydraulic ram is used to push and hammer steel drill rods through the sediments. At selected depths, the steel drive point is removed, allowing the collection of a soil sample when the drill rod is advanced. The soil sample is recovered and the hole then is advanced to the next sample point. The method is relatively fast and generates a minimum amount of waste. At Paducah, DPT has been used successfully in the upper 50 to 60 ft of sediments. Soils will be collected every 5 ft for lithologic description using DPT methods at the C-747-A Oil Landfarm, the C-720 area, and along the storm sewer from the C-400 area.

Rotary drilling methods have proven the most effective in drilling through the gravels of the RGA. These methods include dual-wall reverse circulation (DWRC), rotary sonic, and hollow stem augers (HSA), which are sometimes combined with DPT methods. Section 2.4.1 of this work plan contains descriptions of each of the drilling methods.

If DWRC drilling is used, soil cuttings will be collected every 5 ft from the outlet of the cyclone separator using a large strainer lined with filter paper to catch the fine-grained fraction of the sample. Rotary sonic drilling generates a continuous core contained in a sleeve that will be recovered and laid out for inspection and description.

If the HSA/DPT combination is used, two options are available. One option will be to use the DPT to collect soil samples every 5 ft to the top of the RGA using a core barrel and acetate sleeve to contain the sample. At the top of the RGA, the sampling method will change to HSA split-spoon sampling because the large gravel in the RGA prevents material from entering the DPT core barrel. Alternatively, HSA split spoons may be used from the surface to the base of the RGA.

2.1.2.2 Analytical Samples

At the C-747-A Oil Landfarm, the C-720 area, and along the storm sewer, soil samples will be collected and analyzed to determine contaminant concentrations. Samples from all three areas will be analyzed for VOCs. At the C-720 area and along the storm sewer, the soil samples also will be analyzed for metals and radionuclides. All sampling activities will be conducted in accordance with approved procedures and work guides.

In addition to collecting discrete samples for analysis, the membrane interface probe (MIP) will be used to provide a nearly continuous profile of VOC contamination versus depth. The MIP is used in conjunction with DPT. The technology uses a probe incorporating a heating element and permeable membrane in the subsurface tied back to various types of analytical equipment at the surface. The MIP probe is pushed using DPT. As the probe is pushed downward through the soil column, the soils adjacent to the heating element are heated to a temperature sufficient to vaporize any VOCs present in the soils. The vapors enter the probe through the porous membrane and are transported to the surface using an inert carrier gas and tubing. The vapors then are processed through an array of sensors and analytical equipment that can range from a simple photoionization detector (PID) to a gas chromatograph/mass spectrometer (GC/MS) to a direct sampling ion-trap mass spectrometer (DSITMS). Depending on surface instrumentation, the method provides a nearly continuous semi-quantitative to quantitative profile of VOC concentrations versus depth. Because several different VOCs are expected in the soils, a GC/MS, photoacoustic analyzer, or DSITMS, is recommended for speciation of the VOC vapor stream. To reduce the possibility of overloading the analytical system, a PID may be used to screen the vapor stream for high concentrations of VOCs prior to introduction to the more sensitive analytical system used to quantify and identify the VOCs.

The discrete-depth samples for VOC, metal, and radionuclide analysis will be collected using the more traditional DPT core barrel and acetate sleeve, as described earlier. Soil samples for VOC analysis will be removed from the base of the acetate sleeve as soon as the sleeve is removed from the core barrel. Then the sleeve will be cut open and the lithology of the sample described. After the description is completed, the soil will be placed in a clean bowl and mixed thoroughly to get a more homogenous sample. The resulting mixture will be placed in the appropriate sample jars for analysis. The acetate sleeve and any remaining soil will be handled as IDW.

2.1.3 Groundwater

Temporary borings will be used to collect groundwater samples for field parameters, VOC, and ^{99}Tc analysis for the C-747 Contaminated Burial Yard and the Southwest Plume Dissolved Phase portions of the investigation. Existing RGA MWs in the Southwest Plume area will be sampled for field parameters, VOCs, metals, and radionuclides.

2.1.3.1 Temporary Borings

The general groundwater sampling strategy for this SI focuses on collecting groundwater samples from multiple discrete depths within the RGA using temporary borings at several locations upgradient, (i.e., west, south, and east) of the landfill area. Water sampling will begin at the top of the RGA (approximately 50 ft bgs) and then continue every 10 ft until the base of the RGA is reached (approximately 100 ft bgs). This strategy results in two to six water samples from each boring, depending on the thickness of the RGA actually present in the boring. The borings will be drilled using methods that allow collection of discrete-depth water samples with minimum vertical cross-contamination. Three methods used previously at the PGDP that meet this requirement include DWRC, rotary sonic, and a combination of DPT and HSA drilling. The drilling method selected will influence the water sampling method used.

Both DWRC and rotary sonic drilling allow collection of the water sample inside the drill pipe from the sediments at the face of the drill bit. As soon as each water-sample depth is reached and drilling stops, a water-level indicator will be placed in the hole, and the water level will be monitored each minute for up to 15 minutes. The purpose is to determine how fast the water level returns to equilibrium. The faster the water level stabilizes, the more permeable the interval being sampled and the greater the potential for the interval to be a preferred pathway for contaminant migration. Purging is required to eliminate the impact of the drilling fluid (air for DWRC and potable water for rotary sonic) on the interval being sampled. The water sample will be collected after sufficient water has been purged to allow geochemical parameters (i.e., negative logarithm of the hydrogen-ion concentration [pH], dissolved oxygen, and temperature) to return to original aquifer conditions, as measured in existing MWs in the area. In previous investigations, a bladder pump and low-flow rate sampling was used to collect water samples. Groundwater samples will be collected for analysis for VOCs, including TCE and its degradation products, and ^{99}Tc. During each sampling event, the field parameters of depth to water, groundwater temperature, pH, specific conductance, oxidation reduction potential (Eh), and dissolved oxygen will be collected. Groundwater samples for analysis of metals and radionuclides other than ^{99}Tc will not be collected from the temporary borings, because the results may not represent actual groundwater conditions due to the possible presence of suspended silts and clays in the water sample as a result of drilling. Aside from the fact that metals and radionuclides other than ^{99}Tc generally are not considered potential contaminants of concern within the dissolved phase contaminant plumes, water samples from temporary borings tend to bias high the metals and radionuclides concentrations, because the drilling process may mobilize, briefly, the silts and clays in the sediments and the metals and radionuclides that may be sorbed on to them.

The HSA/DPT combination permits the use of DPT-type water sampling probes within the RGA. The drive-point water sampler is pushed or driven below the bottom of the augers, permitting collection of a relatively undisturbed water sample with minimal cross-contamination. When the drive-point sampler has reached the target depth, the mechanism allowing collection of a groundwater sample will be activated. Groundwater will be pumped to the surface, typically with an inertial pump or mechanical bladder pump, although some air- or inert gas-driven systems are available. A small amount of water, typically less than a gallon, will be purged to reduce the initial turbidity of the water sample. After purging, groundwater samples will be collected for analysis for VOCs, including TCE and its degradation products, and ^{99}Tc. During each sampling event, the field parameters of depth to water, groundwater temperature, pH, specific conductance, Eh, and dissolved oxygen will be collected.

An additional alternative may be used to collect VOC samples. The MIP uses a heating element and gas permeable membrane. The element heats the material surrounding the probe, causing the VOCs contained in the material to vaporize. The vapors enter the probe through a gas permeable membrane and are transported through tubing to the surface by an inert carrier gas. The sample then is analyzed in the field with equipment appropriate to the needs of the investigation. The system is based on DPT methods, but could be deployed within a DWRC or rotary sonic boring. If the MIP is used to collect VOC samples, more traditional sampling methods will be required to collect samples for field parameters and ^{99}Tc analysis.

2.1.3.2 Existing MWs

In addition to the data collected from the temporary borings, results from the sampling of existing MWs will be incorporated into the evaluation of groundwater contamination in the Southwest Plume area. The MWs will be sampled in accordance with approved procedures and work guides. Field parameters of depth to water, groundwater temperature, pH, specific conductance, Eh, and dissolved oxygen will be collected. The water samples will be analyzed for VOCs, metals, and radionuclides. The wells to be used are identified in the site-specific sampling plans described in Section 2.3.

2.1.4 Health and Safety

Sampling to protect the health and safety of the workers is an important part of the project. During drilling and sampling operations, a photoionization detector, or PID, will be used to determine if VOCs are present at hazardous levels in the workers' breathing zone. Personal samplers also will be used to establish baseline values early in the project. Monitoring for radioactive constituents is anticipated because the expected levels of ^{99}Tc at some locations are above maximum contaminant levels (MCLs), and a radiation work permit will be required. Additional details and requirements for health and safety sampling may be found in the project Environmental, Safety, and Health Plan (ES&HP) (BJC 2003a).

2.1.5 IDW

This project will generate soils, groundwater, decontamination water, personal protective equipment (PPE) and plastic, and miscellaneous noncontaminated trash. Some of the materials will be considered hazardous due to TCE contamination. Materials that will have to be sampled for waste characterization include soils and groundwater from the RGA, decontamination water, and PPE and plastic that come in contact with RGA soil or groundwater. These materials will be managed as hazardous waste as described in the project Waste Management Plan (WMP) (BJC 2003b). Section 1.6 of the plan covers waste characterization and sampling and analysis.

2.2 SAMPLE ANALYSIS

Sample analysis for this investigation consists of direct measurement of certain groundwater parameters in the field, analysis of groundwater samples for VOCs and ^{99}Tc, analysis of soil samples for VOCs, metals, and radionuclides, and characterization of project-generated waste materials. Specific analytical requirements, methods, and procedures are described in Sect. 2.8 of this document and in further detail in the Quality Assurance Project Plan (QAPP) for this SI Work Plan (BJC 2003c).

2.2.1 Soils

Both field and fixed lab analyses will be performed on the soils of the upper continental deposits from borings at the C-747-A Oil Landfarm, the C-720 area, and along the storm sewer from the C-400 area to Outfall 008. The next two sections summarize the required soil analyses.

2.2.1.1 Field Analysis

The field analysis will consist of vertical profiling of VOC concentrations in the shallow soils using the DPT/MIP combination. The operation of the MIP is described in Section 2.1.2.2. Because several different VOCs are expected in the soils, a GC/MS, photoacoustic analyzer, or DSITMS is recommended for speciation of the VOC vapor stream. To reduce the possibility of overloading the analytical system, a PID may be used to screen the vapor stream for high concentrations of VOCs prior to introduction to the more sensitive analytical system used to identify and quantify the VOCs. Calibration and use of this equipment will be in accordance with manufacturers' operations manuals, work guides, or applicable approved procedures. These documents will be available on-site for reference by the project team members.

2.2.1.2 Lab Analysis

The discrete depth soil samples at the C-747-A Oil Landfarm will be analyzed for VOCs only, while the samples collected from the C-720 area and along the storm sewer will be analyzed for VOCs, metals, and radionuclides. The samples for metals and radionuclide analysis will be sent to a fixed-base laboratory. Because the VOC data, in conjunction with the MIP profiling, will be used to guide the implementation and placement of soil borings, the sample analysis methods for these samples must be capable of rapid turnaround of analytical results to keep fieldwork moving forward and to prevent collecting unnecessary data. One option would be to send all samples to a fixed-base lab and require a maximum turnaround time of seven days, with shorter turnaround times preferable. Using this option will require careful planning of the drilling sequence to keep standby time at a minimum. The second option would be the use of a mobile field laboratory, furnished with analytical equipment sensitive enough to meet the required minimum detection limits for TCE and its degradation products. If a mobile field lab is used, then 10% of the samples will be sent to a fixed-base lab for confirmation.

2.2.2 Groundwater

As with the soil samples, groundwater samples will be analyzed using both field methods and fixed-base laboratories, depending on the parameter of interest. Groundwater properties will be measured in the field, while contaminant levels may be measured using some combination of field methods, mobile laboratories, or fixed-base laboratories.

2.2.2.1 Field Parameters

Certain parameters, such as depth to water, pH, dissolved oxygen, specific conductance, Eh, and temperature will be measured in the field using appropriate field instruments such as meters and probes and in-line flow cells. Calibration and use of this equipment will be in accordance with manufacturers' operations manuals, work guides, or applicable approved procedures. These documents will be available on-site for reference by the project team members.

2.2.2.2 Temporary Borings

In addition to field parameters, groundwater samples from temporary RGA borings will be analyzed for VOCs and ^{99}Tc. Three options for sample analysis are available for VOCs. Two options are available for ^{99}Tc.

Decisions about the need for and placement of each boring will be based on the VOC data collected during the investigation. The sample analysis methods must be capable of rapid turnaround of analytical results to keep fieldwork moving forward and to prevent collecting unnecessary data. One option would be to send all samples to a fixed-base lab and require a maximum turnaround time of seven days, with shorter turnaround times preferable. Using this option will require careful planning of the drilling sequence to keep standby time at a minimum. The second option would be the use of a mobile field laboratory furnished with analytical equipment sensitive enough to meet the required minimum detection limits for TCE and its degradation products. If a mobile field lab is used, then 10% of the samples will be sent to a fixed-base lab for confirmation. If the MIP system is used to sample for VOCs, then use of a portable GC/MS, DSITMS, or photoacoustic analyzer becomes a third option. As with the mobile field laboratory, the analytical equipment selected for use with the MIP must be sensitive enough to meet the required minimum detection limits for TCE and its degradation products. If the MIP and a portable unit are used, then 10% of the samples will be collected as a liquid and sent to a fixed-base lab for confirmation.

For ^{99}Tc, the two options are a mobile field lab or a fixed-base lab. Since field decisions will not be dependent on ^{99}Tc activities in the groundwater, rapid turnaround times will not be required. The lab selection will be determined by the option that provides the best value. If a mobile field laboratory is selected, then 10% of the samples will be sent to a fixed-base lab for confirmation.

2.2.2.3 Existing MWs

Several existing MWs will be sampled in conjunction with this investigation. The analytes of interest are VOCs, metals, and radionuclides. To get the most utility from the data, the analytical results need to be available early in the project to serve as baseline information, with the VOC and radionuclide data being the most valuable. Sampling the existing MWs, while the rest of the project is mobilizing, and using a fixed-base lab with a maximum turnaround time of 14 days for the VOCs and radionuclides is recommended to obtain the most benefit from the data.

2.2.3 Waste Characterization

Analysis of waste characterization samples will not be a time-critical activity. All samples will be sent to a fixed-base lab for analysis. Details of the sampling and analytical requirements for waste characterization are described in Sect. 1.6 of the WMP (BJC 2003b)

2.3 SITE-SPECIFIC SAMPLING PLANS

The following sections present the sampling plans and logic for each of the units to be investigated.

2.3.1 General Sampling Strategy

The general sampling strategy for this Southwest Plume SI focuses on the following activities:

- determining the integrity of the storm sewer between the C-400 Building and Outfall 008 using a video system designed for inspecting underground utilities;
- profiling VOC contamination in the upper continental deposits at SWMU 001, the C-720 Building area, and along the storm sewer using the DPT/MIP combination;
- collecting soil samples for analysis in the upper continental deposits at SWMU 001, the C-720 Building area, and along the storm sewer using DPT;
- collecting groundwater samples for analysis from multiple discrete depths within the RGA using temporary borings at SWMU 004 and in the dissolved phase plume using methods that allow collection of discrete depth water samples with minimum vertical cross-contamination;
- collecting groundwater samples for analysis from existing groundwater MWs in the vicinity of the areas being investigated; and

- installing up to four RGA groundwater MWs to monitor changes in Southwest Plume groundwater contamination over time.

2.3.2 C-747-A Oil Landfarm - SWMU 001

Between 1973 and 1979, the C-747-C Oil Landfarm was used for landfarming of waste oils contaminated with TCE; uranium; polychlorinated biphenyls (PCBs); and 1,1,1-trichloroethane (TCA). These waste oils are believed to have been derived from a variety of plant processes. The Landfarm consisted of two 1125 ft^2 plots that were plowed to a depth of 1 to 2 ft. Waste oils were spread on the surface every 3 to 4 months, then the area was limed and fertilized. Investigations that have collected data on SWMU 001 include the Phase I and Phase II Site Investigations, additional sampling performed to support the Waste Area Group (WAG) 23 Feasibility Study, the WAG 23 Remedial Action (RA), and the WAG 27 Remedial Investigation (RI). These investigations and actions identified VOCs, PCBs, dioxins, semivolatile organic compounds, heavy metals, and radionuclides as potential contaminants of concern. As part of the WAG 23 RA, 23 yd^3 of dioxin-contaminated soil were excavated and removed from the unit. Samples collected to support the WAG 23 RA indicated *cis*-1,2-dichloroethene (DCE) concentrations as high as 2,400,000 μg/kg. During the WAG 27 RI, TCE concentrations as high as 439,000 μg/kg and vinyl chloride (VC) concentrations as high as 4800 μg/kg were identified in the shallow soils. TCE values from the WAG 27 RI generally were less than 100,000 μg/kg. For comparison, the highest TCE value at the southeast corner of the C-400 Building was in excess of 1,100,000 μg/kg, or nearly three times the level seen at SWMU 001. This Southwest Plume SI will focus on the soils containing the highest VOC concentrations as defined during the WAG 27 RI. The problem statement for this unit reads:

Hazardous substances, primarily TCE, have been detected above the maximum concentration limit in a groundwater MW immediately north of SWMU 001. During previous investigations, hazardous substances, including TCE, were detected in the subsurface soils within the boundaries of the unit. It is unknown how and at what rate the concentrations of TCE and its degradation products have changed in the soil.

The principal study questions to be answered for this unit are as follows.

Have the concentrations of TCE, its degradation products, and other VOCs changed compared to the concentrations measured during the WAG 27 RI in 1998?

Have the ratios of TCE to its degradation products changed compared to the ratios measured during the WAG 27 RI in 1998?

Has the distribution of VOCs with depth changed compared to the distribution measured during the WAG 27 RI in 1998?

The decision rules that flow from the principal study questions are these.

If the concentrations of TCE, its degradation products, and other VOCs have changed by more than ± 20 % compared to the concentrations measured during the WAG 27 RI in 1998, then determine the magnitude of the change and the probable mechanism(s) for the change.

If the ratios of TCE to its degradation products have changed by a factor of 10 or more compared to the ratios measured during the WAG 27 RI in 1998, then determine the average rate of change and modify the conceptual model and risk assessment accordingly.

If the highest concentration of VOCs has changed in depth by 5 ft or more compared to the distribution measured during the WAG 27 RI in 1998, then determine the average rate of change and modify the conceptual model and risk assessment accordingly.

To answer the principal study questions and implement the decision rules, five DPT/MIP borings (shown in Fig. 3) will be placed in the core of the soil contamination area defined during the WAG 27 RI. In addition to the MIP profile, soil samples will be collected at 15, 30, 45, and 60 ft bgs and will be sent to a lab for VOC analysis. Table 1 provides a summary for each boring. To determine if significant changes have occurred, various plots will be made comparing individual VOC concentrations from WAG 27 and this investigation and comparing individual VOC distributions versus depth from WAG 27 and this investigation. Figure 4 is an east-west cross-section through the core of the contamination, as defined by the WAG 27 RI. Figure 5 is a north-south cross-section through the same area.

Table 1. Summary of soil sampling and analysis for the C-747-A Oil Landfarm - SWMU 001

Boring	Drilling Method	Planned Total Depth (ft)	Sample Depth (ft bgs)	Media	Analytes
Planned					
001-201	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs
001-202	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs
001-203	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs
001-204	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs
001-205	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs
Total Planned - 5		300'	20 samples		
Contingency					
001-206	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs
001-207	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs
001-208	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs
Total Contingency - 3		180'	12 samples		

DPT = Direct Push Technology
MIP = Membrane Interface Probe
VOCs = volatile organic compounds
ft = feet
bgs = below ground surface

Three contingency soil borings have been allocated to this unit. The following decision rule will be applied to the implementation of the contingency borings.

If Borings 001-201, 001-203, or 001-205 encounter total VOC concentrations greater than 10,000 µg/kg, then a contingency DPT/MIP boring will be installed 25 ft east, west, or south of Borings 001-201, 001-203, or 001-205, respectively, to determine the lateral extent of the contamination.

Table 1 summarizes the contingency borings.

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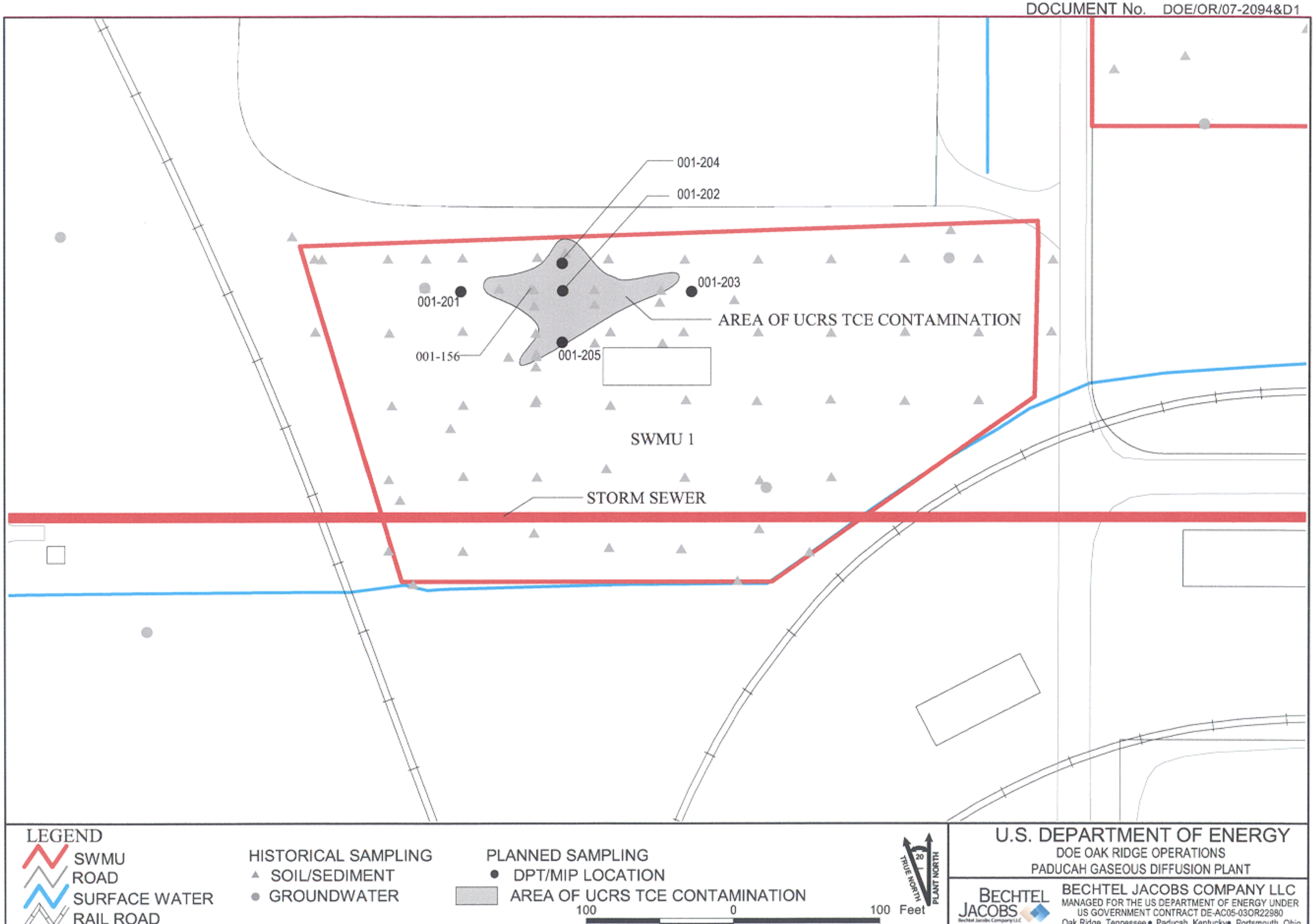

Fig. 3. SWMU 1 historical and planned sampling.

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PADUCAH GASEOUS DIFFUSION PLANT

BECHTEL JACOBS COMPANY LLC
MANAGED FOR THE US DEPARTMENT OF ENERGY UNDER US GOVERNMENT CONTRACT DE-AC05-03OR22980
Oak Ridge, Tennessee • Paducah, Kentucky • Portsmouth, Ohio

Science Applications International Corporation
P.O. Box 2502
Oak Ridge, Tennessee 37831

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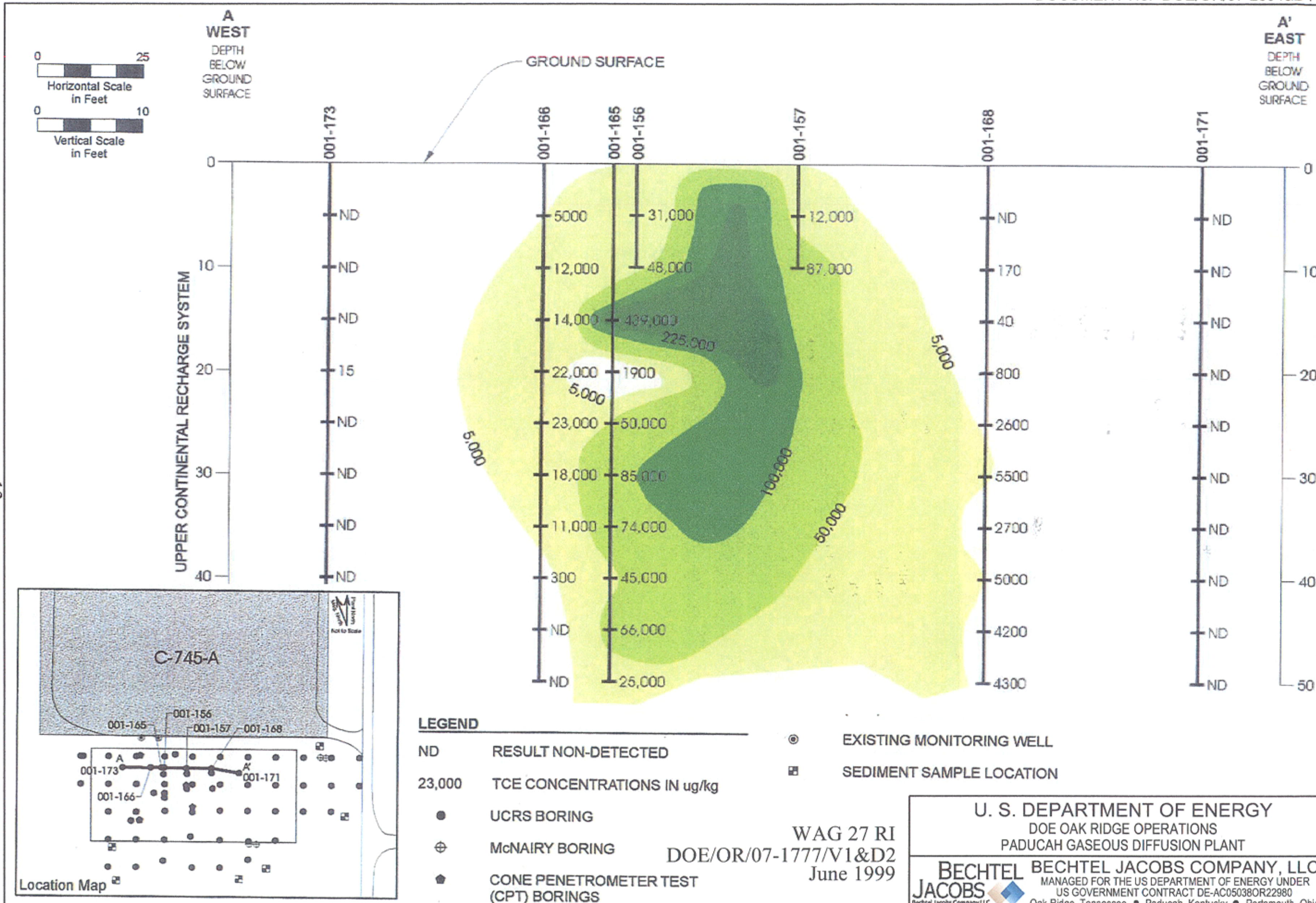

Fig. 4. East-west cross-section B-B' showing TCE distribution in UCRS soils at SWMU 1.

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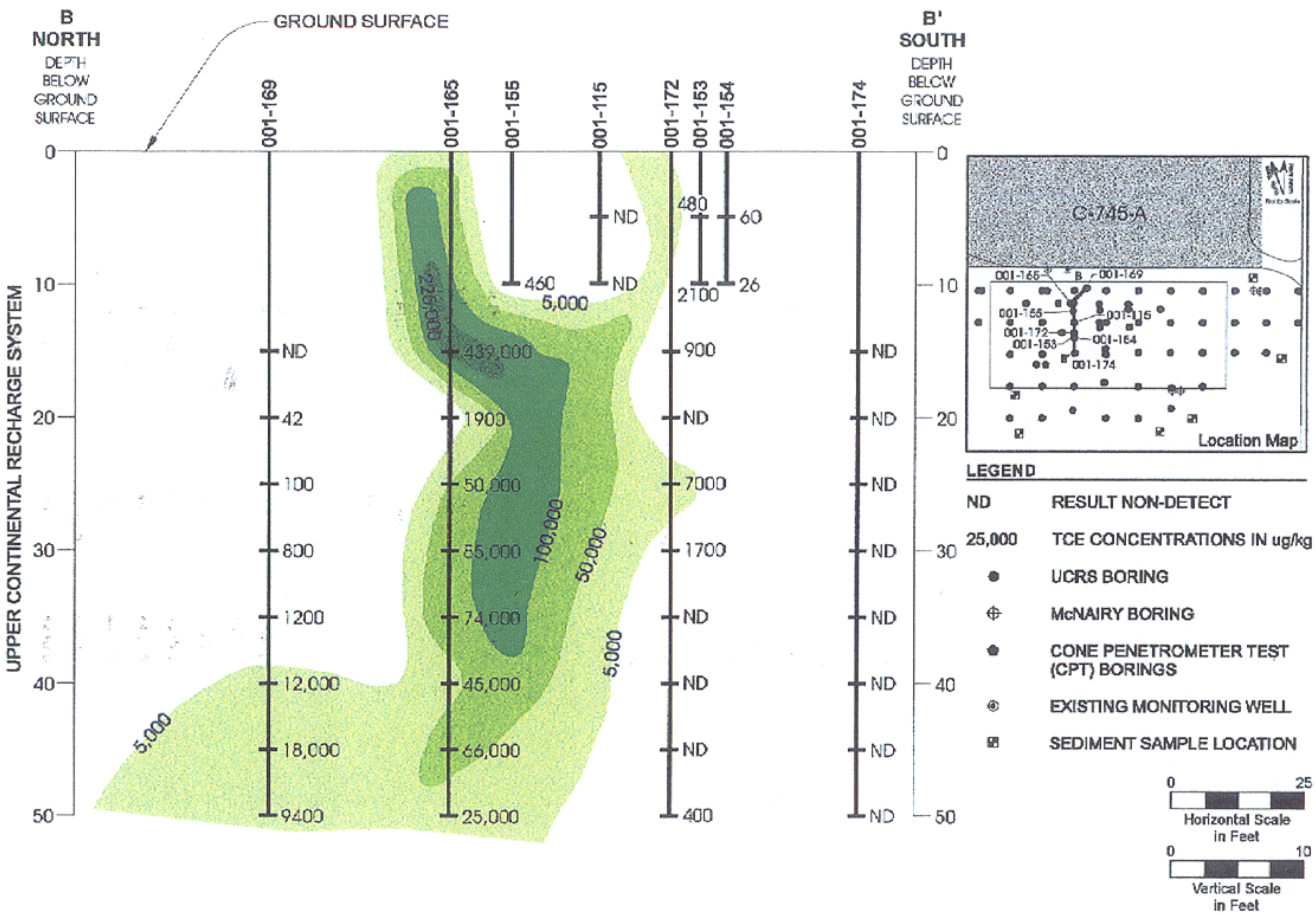

WAG 27 RI (DOE/OR/07-1777/V1&D2) June 1999

Fig. 5. North-south cross-section B-B' showing TCE distribution in UCRS soils at SWMU 1.

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2.3.3 C-720 Area

There are two areas of VOC contamination at the C-720 Building that have been targeted for further investigation. One area is underneath the parking lot and equipment storage area at the northeast corner of the building. The second area is located underneath the parking lot adjacent to the loading docks at the southeast corner of the building. The areas of investigation and the location of planned borings are shown in Fig. 6.

The problem statement for the C-720 area reads as follows.

Temporary borings from previous investigations and MWs have encountered hazardous substances above background levels in the soils and groundwater in the vicinity of the C-720 Building. The extent and magnitude of two areas of contamination near the east end of the building are not known.

The principal study question to be answered for this area is as follows.

Have the concentrations of TCE, its degradation products, or other VOCs changed compared to the concentrations measured during the WAG 27 RI in 1998?

The decision rule resulting from the principal study question is as follows.

If the concentrations of TCE, its degradation products, or other VOCs have changed by more than ± 20% compared to the concentrations measured during the WAG 27 RI in 1998, then determine the magnitude of the change and the probable mechanism(s) for the change.

2.3.3.1 Northeast Corner

The release mechanism for the northeast corner contamination is believed to be routine equipment cleaning and rinsing performed in the area. Solvents were used to clean parts, and the excess solvent may have been discharged on the ground. Spills and leaks from the cleaning process also may have contaminated surface soils in the area. Solvents may have migrated as dissolved contamination, as rainfall percolating through the soils and migrating to deeper soils and the shallow groundwater, or as dense nonaqueous-phase liquid (DNAPL), migrating to adjacent and underlying soils. In WAG 27, TCE concentrations as high as 8100 μg/kg were identified in Boring 720-027, which was located immediately north of the parking lot. This Southwest Plume SI will focus on the soils underneath the parking lot, with VOCs, metals, and radionuclides being the contaminants of interest.

The principal study question to be answered for this area is as follows.

What is the current concentration of the VOCs, metals, and radionuclides in the soils below the parking lot at the northeast corner of the C-720 Building?

The decision rule resulting from the principal study question is as follows.

If the extent and concentration of the VOCs, metals, or radionuclides in the soils below the parking lot at the northeast corner of the C-720 Building are different by more than ± 20 % compared to that previously modeled for the area, then modify the conceptual model and risk assessment accordingly.

To answer the principal study questions and implement the decision rules for the northeast corner, six DPT/MIP borings, shown in Fig. 6, will be placed between the north edge of the parking lot and a storm sewer to which all surface runoff for the parking lot flows. In addition to the MIP profile, soil

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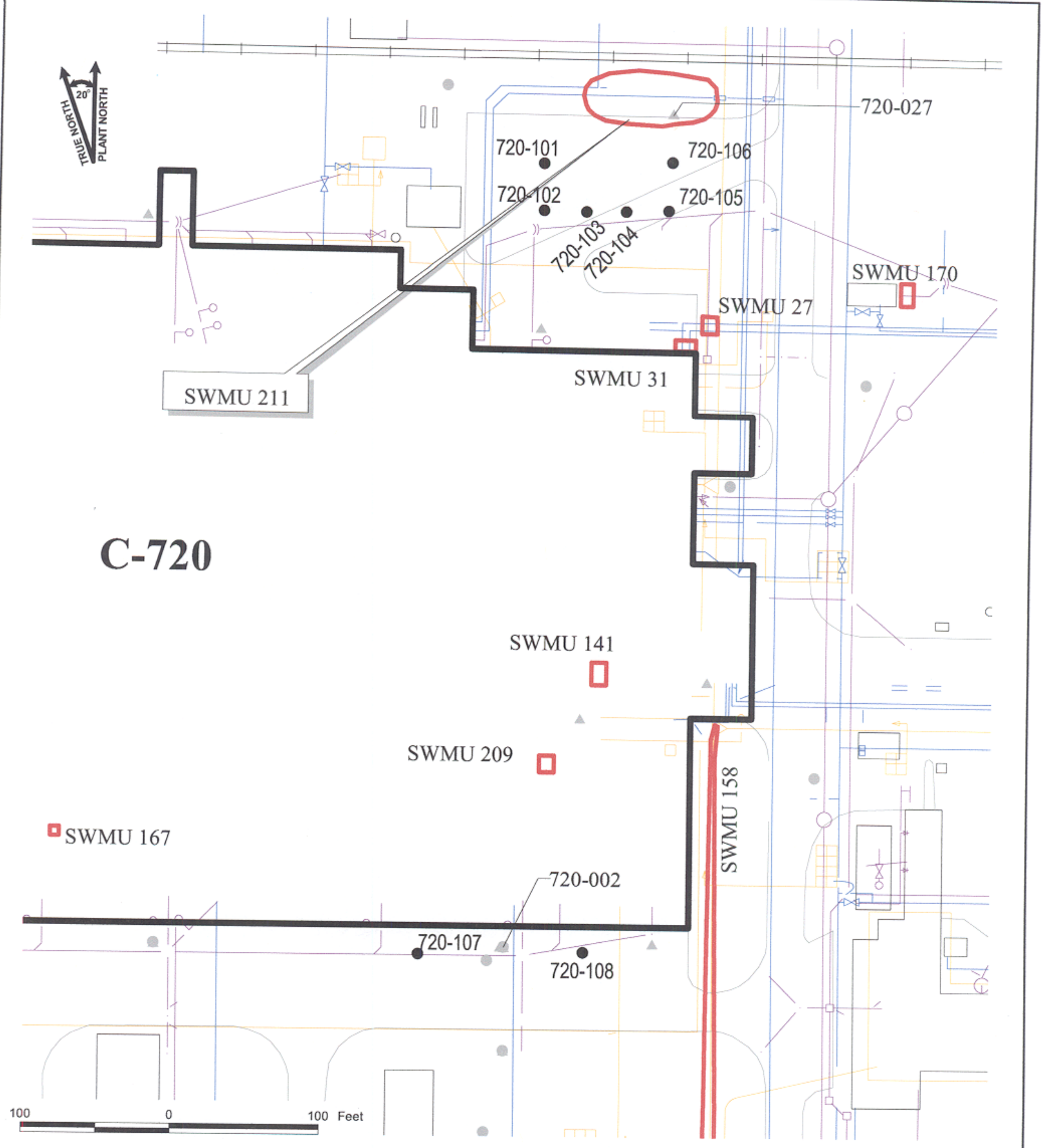

LEGEND:

SWMU	HISTORICAL SAMPLING	UNDERGROUND UTILITIES
ROAD	▲ SOIL/SEDIMENT	WATER LINE
SURFACE WATER	● GROUNDWATER	SEWER LINE
RAIL ROAD	PLANNED SAMPLING	ELECTRICAL DUCT
	● DPT/MIP LOCATION	

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Fig. 6. C-720 historical and planned sampling.

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samples will be collected at 15, 30, 45, and 60 ft bgs and will be sent to a fixed-base lab for VOC, metals, and radionuclide analysis. A shallow groundwater well located at the east edge of the parking lot, MW204, also will be sampled for VOCs, metals, and radionuclides. A deeper RGA well (MW203) will be sampled along with other wells within the boundaries of the Southwest Plume as part of the dissolved-phase work described in Sect. 2.3.5. Table 2 provides a summary for each boring.

Table 2. Summary of soil and groundwater sampling and analysis for the C-720 Building area

Boring	Drilling Method	Planned Total Depth (ft)	Sample Depth (ft bgs)	Media	Analytes
Planned					
720-101	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs, Metals, Rad
720-102	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs, Metals, Rad
720-103	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs, Metals, Rad
720-104	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs, Metals, Rad
720-105	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs, Metals, Rad
720-106	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs, Metals, Rad
720-107	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs, Metals, Rad
720-108	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs, Metals, Rad
Total Planned - 8		480'	32 samples		
Contingency					
720-109	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs, Metals, Rad
720-110	DPT/MIP	60'	15', 30', 45', 60'	Soils	VOCs, Metals, Rad
Total Contingency - 2		120'	8 samples		
Monitoring Wells (MWs)					
MW204	UCRS Well			Groundwater	VOCs, Metals, Rad

ft = feet
bgs = below ground surface
DPT = Direct Push Technology
VOCs = volatile organic compounds
MIP = Membrane Interface Probe
UCRS = Upper Continental Recharge System
Rad = Total uranium (U), ^{234}U, ^{235}U, ^{238}U, neptunium-237, plutonium-239, technetium-99, Gross Alpha, and Gross Beta

2.3.3.2 Southeast Corner

The release mechanism for the southeast corner is less clear. The area of contamination discovered during WAG 27 is near the outlet to one of the storm drains for the east end of the building. There also is a storm sewer inlet for the southeast parking lot in the vicinity. The north edge of the parking lot, where the contamination occurs, also is the location of one of the loading docks for the C-720 Building, an area where chemicals, including solvents, may have been loaded or unloaded. The VOCs at the southeast corner may be the result of activities within the building which resulted in VOCs entering the storm drains for the southeast corner of the building or from activities such as spills or leaks on the loading dock or in the southeast parking lot. This Southwest Plume SI will focus on the soils underneath the parking lot and immediately adjacent to the loading dock, with VOCs, metals, and radionuclides being the contaminants of interest.

The principal study question to be answered for this area is as follows.

What is the current concentration of the VOCs, metals, and radionuclides in the soils below the parking lot at the southeast corner of the C-720 Building?

The decision rule resulting from the principal study question is as follows.

If the extent and concentration of the VOCs, metals, or radionuclides in the soils below the parking lot at the southeast corner of the C-720 Building is different by more than ± 20 % compared to that previously modeled for the area, then modify the conceptual model and risk assessment accordingly.

To answer the principal study questions and implement the decision rules for the southeast corner, two DPT/MIP borings will be placed, one east and one west of the location for 720-002 (see Fig. 6), through the parking lot adjacent to the C-720 Building loading dock. In addition to the MIP profile, soil samples will be collected at 15, 30, 45, and 60 ft bgs and will be sent to a lab for VOC, metals, and radionuclide analysis. Table 2 provides a summary for each boring. To determine if significant changes have occurred, various plots will be made comparing individual VOC concentrations from WAG 27 and this investigation and comparing individual VOC distributions versus depth from WAG 27 and this investigation.

2.3.3.3 Contingency Borings

Two contingency borings have been allocated to this unit. The following decision rule will be applied to the implementation of the contingency borings.

If any of the planned borings encounter total VOC concentrations greater than 10,000 µg/kg, then a contingency boring will be installed 50 ft away from the planned boring. The direction of the contingency boring relative to the planned boring will be dependent on the distribution of contamination seen in the planned borings and the location of the trigger boring relative to the other planned borings.

The contingency borings are summarized in Table 2.

2.3.4 Storm Sewer from C-400 to Outfall 008 - SWMU 102

During the WAG 6 RI, VOC contamination of subsurface soils was identified near two of the lateral lines that feed into the main storm sewer that runs south of the C-400 Building to Outfall 008 on the west side of PGDP. At one time, the eastern lateral appears to have been connected to the TCE degreaser sump inside the C-400 Building. The TCE that leaked from the sump/storm sewer connection to the surrounding soils has been identified as a source of groundwater contamination. There is a possibility that some of the TCE was transported down the lateral to the main storm sewer (then west toward Outfall 008), encountered another breach in the storm sewer, and leaked to the surrounding soils to become a source of TCE to the Southwest Plume. The area of investigation is shown in Fig. 7. The problem statement for this unit reads as follows.

Processes associated with the C-400 Building are documented sources of subsurface soil and groundwater contamination. The subject storm sewer collects storm water runoff from the C-400 area. Additionally, the storm sewer may have captured liquids from C-400 processes. It is not known if the storm sewer has transported contaminants or if contaminants have leaked from the storm sewer to the surrounding soils.

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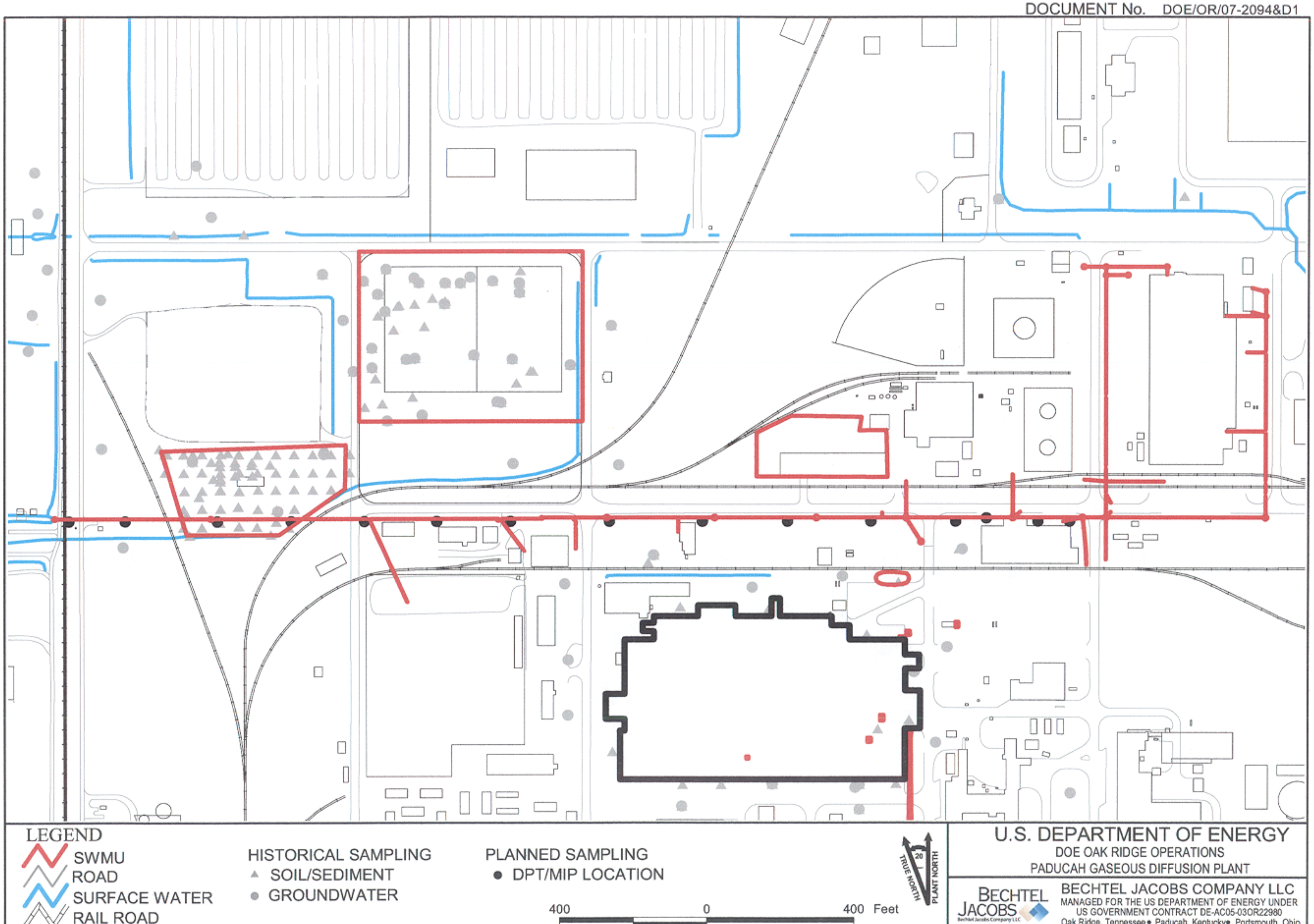

Fig. 7. Storm sewer historical and planned sampling.

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The principal study questions to be answered for this unit are these.

What is the current structural integrity of the storm sewer?

Are there contaminants in the backfill material of the storm sewer and the adjacent soils that may act as sources of contamination for the Southwest Plume?

2.3.4.1 Construction Details

The C-400 to Outfall 008 storm sewer drains the central west portion of the plant. Major areas and buildings that contribute storm water runoff to the system include all of the following:

- C-631 Cooling Towers,
- C-331 Process Building – roof drains for northwest quadrant,
- C-310 Building – roof drains for north half,
- C-410/C-420 Complex,
- C-400 Building,
- C-409 Building,
- C-600 Steam Plant area,
- C-720 Building – roof drains for north and west sides and associated shops on north side,
- C-746-H3 Storage Pad, and
- C-740 Storage Yard.

East of the C-400 Building, the main line begins as a 15-inch diameter line, enlarging to an 18-inch, then to a 42-inch, and finally to a 48-inch diameter line. From the east side of the C-400 Building west to Outfall 008, the line is a 60-inch-diameter reinforced concrete pipe. The bottom of the pipe is between 13 and 15 ft bgs. The feeder lines into the main line range from 24-inch concrete down to 8-inch vitreous clay pipe.

2.3.4.2 Utility Survey

To answer the first principal study question, a video system for inspecting underground utilities will be deployed to inspect approximately 3000 ft of the storm sewer, starting at the west side of the C-400 Building and surveying out to Outfall 008. After the video is evaluated, the following decision rules will be implemented for the placement of up to 15 DPT/MIP borings.

If the video camera survey detects holes or fractures in the bottom half of the storm sewer, then plan a DPT/MIP boring for each location to sample for contamination.

If more than 15 holes or fractures are found in the bottom half of the storm sewer, then place priority on the 15 holes or fractures located closest to the C-400 and C-720 Buildings.

2.3.4.3 DPT/MIP Borings

Each DPT/MIP will be placed as close to the storm sewer as possible so soil samples may be collected from the base of the backfill material in which the storm sewer rests. The planned depth for these borings is 20 ft. The soil samples will be sent to a lab for analysis for VOCs, metals, and radionuclides.

The following decision rules will be applied to the implementation of the contingency borings.

If no VOC contamination is found in the 15 baseline borings, then place up to 15 additional borings at identified holes or fractures along the storm sewer west of the initial study area.

If VOC contamination is found in one or more of the 15 baseline borings, then use one or more additional borings to determine the area and vertical extent of the contamination.

For this unit, 300 ft of contingency DPT/MIP drilling has been allocated. If an area of VOC contamination is found, then contingency borings will be used to define the contaminated volume down to the top of the RGA (at approximately 60 ft) or to the depth of refusal. Table 3 provides a summary for each boring.

Table 3. Summary of soil sampling and analysis for the storm sewer from C-400 to Outfall 008 - SWMU 102

Boring	Drilling Method	Planned Total Depth (ft)	Sample Depth (ft bgs)	Media	Analytes
Planned					
102-001	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
102-002	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
102-003	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
102-004	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
102-005	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
102-006	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
102-007	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
102-008	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
102-009	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
102-010	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
102-011	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
102-012	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
102-013	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
102-014	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
102-015	DPT/MIP	20'	20'	Soils	VOCs, Metals, Rad
Total Planned - 15		300'	15 samples		
Total Contingency - 15	DPT/MIP	300'	15 samples	Soils	VOCs, Metals, Rad

ft = feet
bgs = below ground surface
DPT = Direct Push Technology
VOCs = volatile organic compounds
MIP = Membrane Interface Probe
UCRS = Upper Continental Recharge System
Rad = Total uranium (U), ^{234}U, ^{235}U, ^{238}U, neptunium-237, plutonium-239, technetium-99, Gross Alpha, and Gross Beta

2.3.5 C-747 Contaminated Burial Yard - SWMU 004

The C-747 Contaminated Burial Yard (SWMU 004) operated from 1951 through 1958, and was used for disposal of contaminated and uncontaminated trash, some of which was burned. Waste materials from C-400, originally designated for the C-404 Burial Area may have been placed at SWMU 004 as well. Scrapped equipment with surface contamination from the enrichment process also was buried. The site consists of several pits excavated to about 15 ft. The waste was placed in the pits and was covered with 2 to 3 ft of soil. A 6-inch clay cap was installed in 1982. The site was investigated during the

Comprehensive Environmental Response, Compensation, and Liability Act Phase II SI and the WAG 3 RI. The contaminants found included radionuclides, heavy metals, solvents, semivolatile organics, and PCBs. This Southwest Plume SI will focus on the RGA groundwater east and west of the unit. The intent of the investigation is to determine if SWMU 004 is contributing VOC and ^{99}Tc contamination to the RGA and, if so, how much. The problem statement for this unit reads as follows.

Hazardous substances, including VOCs and radionuclides, have been detected above MCLs in the subsurface soils and groundwater within and immediately adjacent to the boundaries of SWMU 004. It is unknown if or how much contamination is entering the RGA from this unit.

The principal study questions for this unit are these.

What are the VOCs and concentrations in the RGA upgradient (east) of SWMU 004?

What are the VOCs and concentrations in the RGA downgradient (west) of SWMU 004?

What are the ^{99}Tc activities in the RGA upgradient (east) of SWMU 004?

What are the ^{99}Tc activities in the RGA downgradient (west) of SWMU 004?

To answer the principal study questions, four temporary groundwater borings will be drilled and sampled east of SWMU 004, five temporary groundwater borings will be drilled and sampled west of SWMU 004, and one temporary groundwater boring will be drilled and sampled south of SWMU 004. The locations of these borings are shown in Fig. 8. All borings will be drilled to the base of the RGA, approximately 100 ft bgs. Soil cuttings (or cores in the case of rotary sonic) will be collected and described every 5 ft and at significant lithology changes. Beginning at the top of the RGA, water samples will be collected every 10 ft within the RGA resulting in 4 to 6 water samples from each boring, depending on the thickness of the RGA (30 to 50 ft) present in the boring. For planning purposes, the RGA is assumed to have an average thickness of 40 ft. During each sampling event, the field parameters of depth to water, groundwater temperature, pH, specific conductance, Eh, and dissolved oxygen will be collected. Groundwater samples will be analyzed for VOCs and ^{99}Tc. Groundwater samples for analysis of metals and radionuclides other than ^{99}Tc will not be collected from the temporary borings, because the results may not represent actual groundwater conditions due to the possible presence of suspended silts and clays in the water sample as a result of drilling. After drilling and sampling are completed, the borings will be abandoned. Table 4 provides a summary for each boring.

After the results of the groundwater sampling have been received and evaluated, the following decision statements can be addressed.

If concentrations in the RGA for individual VOCs are higher by 20% or more on the downgradient side of SWMU 004 than on the upgradient side, then the unit is contributing VOC contamination to the RGA, and the conceptual model and risk assessment should be adjusted accordingly.

If ^{99}Tc activities in the RGA are higher by 20% or more on the downgradient side of SWMU 004 than on the upgradient side, then the unit is contributing ^{99}Tc contamination to the RGA, and the conceptual model and risk assessment should be adjusted accordingly.

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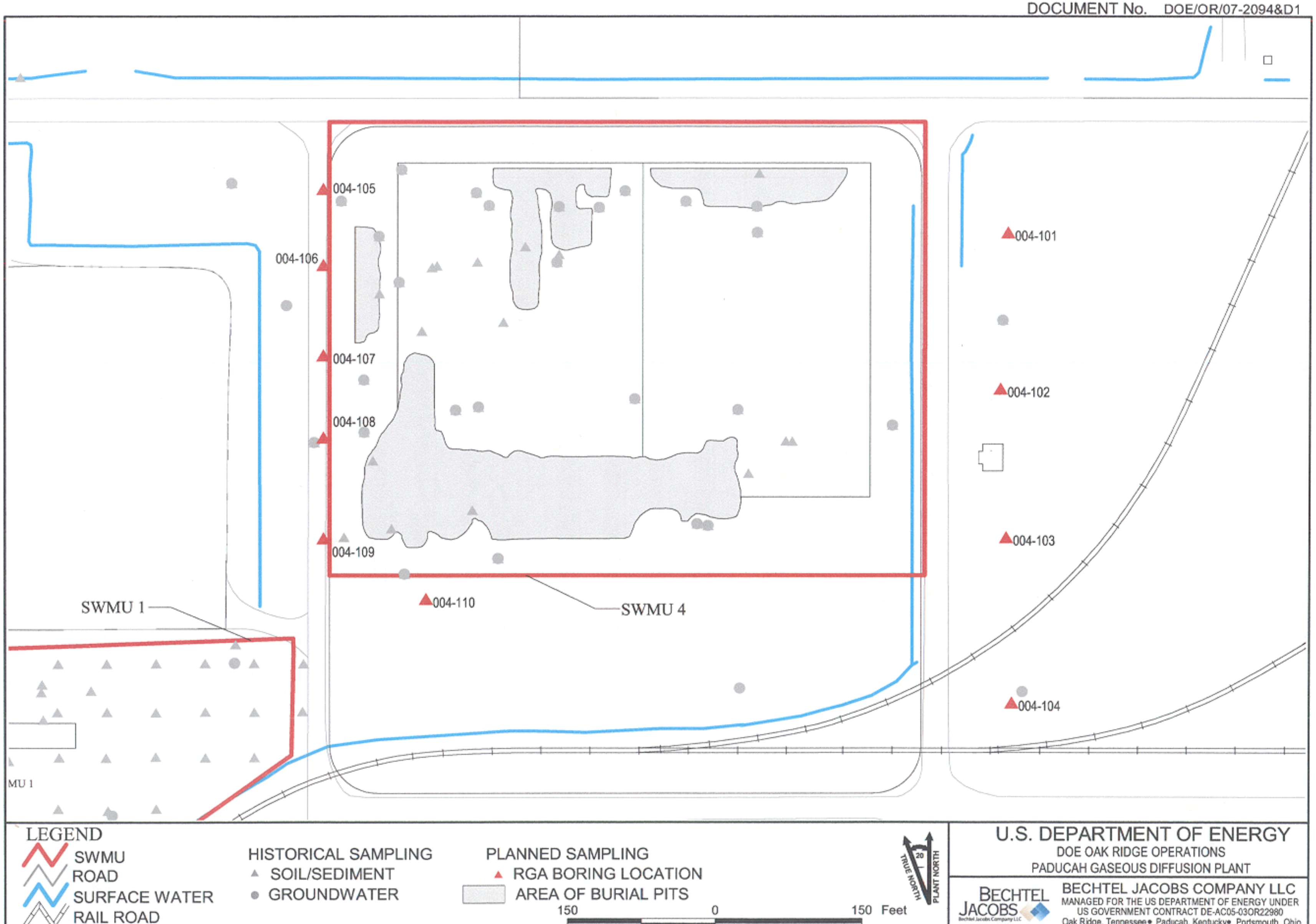

Fig. 8. SWMU 4 historical and planned sampling.

FIGURE No. c5ac90001sk652r3.apr
DATE 10-06-03

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Table 4. Summary of groundwater sampling and analysis for the C-747 Contaminated Burial Yard - SWMU 004

Boring	Drilling Method	Planned Total Depth (ft)	Sample Depth (ft bgs)	Media	Analytes
Planned					
004-101	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
004-102	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
004-103	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
004-104	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
004-105	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
004-106	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
004-107	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
004-108	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
004-109	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
004-110	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
Total Planned - 10		1000'	50 samples		
Contingency - None					

ft = feet
DWRC = dual-wall reverse circulation
VOCs = volatile organic compounds
bgs = below ground surface
^{99}Tc = technetium-99
HSA = hollow-stem auger

The groundwater data also will be used to determine the location and screen depth for a single RGA MW. The well will be placed to monitor the groundwater interval containing the highest VOC concentrations.

2.3.6 Southwest Plume Dissolved Phase - SWMU 210

The Southwest Plume was first identified during the WAG 27 RI in 1998. Additional work to characterize the plume was performed as part of the Data Gaps Investigation in 1999. The primary contaminants are TCE, with lesser amounts of other VOCs and ^{99}Tc. The problem statement for this portion of the Southwest Plume SI reads as follows:

Hazardous substances, primarily VOCs and ^{99}Tc, have been detected above the maximum concentration limit in groundwater MWs west of the C-400 Building and south of the groundwater contamination area identified as the NW Plume. This area of groundwater contamination has been named the Southwest Plume. The existing MWs are not located such that the types and levels of contaminants migrating beyond the plant security fence can be monitored. There is no information currently available to determine if the C-400 Building is a contributor to the Southwest Plume.

The principal study questions to be addressed during this phase of the investigation include all of the following.

What VOCs are present in the RGA groundwater where the RGA groundwater passes below the west plant security fence?

What are the concentrations of VOCs in the RGA groundwater where the RGA groundwater passes below the west plant security fence?

What are the ^{99}Tc activities in the RGA groundwater where the RGA groundwater passes below the west plant security fence?

Is the C-400 Building contributing VOCs or ^{99}Tc to the RGA groundwater in the Southwest Plume?

To address the first three principal study questions, seven temporary groundwater borings are planned just east of the security fence at the west side of PGDP. These borings will span 1200 ft of the 1900-ft plume width at the fenceline, as mapped currently. The Permeable Treatment Zone (PTZ) MWs immediately west of the fence can monitor only 100 ft of the width of the plume. Additionally, the VOCs measured in the PTZ wells have been lower than temporary borings completed earlier in the same area. The temporary borings will be used to confirm the PTZ well results. Three temporary groundwater borings are planned for the area immediately west of the steam plant and C-400 to address the fourth question. The planned locations for the borings are shown in Fig. 9. In addition to the temporary borings, existing RGA MWs within the current boundaries of the plume will be sampled. Where possible, the sampling will be done as part of the routine sampling scheduled for each well. Table 5 provides a listing of each well to be sampled.

All borings will be drilled to the base of the RGA, approximately 100 ft bgs. Soil cuttings (or cores in the case of rotary sonic) will be collected and described every 5 ft and at significant lithology changes. Water sampling will begin at the top of the RGA (approximately 50 ft bgs) and then continue every 10 ft until the base of the RGA is reached (approximately 100 ft bgs). For planning purposes, the RGA is assumed to have an average thickness of 40 ft. During each sampling event, the field parameters of depth to water, groundwater temperature, pH, specific conductance, Eh, and dissolved oxygen will be collected. Groundwater samples will be analyzed for VOCs and ^{99}Tc. Groundwater samples for analysis of metals and radionuclides other than ^{99}Tc will not be collected from the temporary borings because the results may not represent actual groundwater conditions due to the possible presence of suspended silts and clays in the water sample as a result of drilling. After drilling and sampling are completed, the borings will be abandoned. Table 5 provides a summary for each boring.

2.3.7 New MWs

If the core of the Southwest Plume (an area with TCE concentrations greater than 1000 µg/L) is identified, then a permanent MW will be installed near the west plant security fence to monitor changes in contaminant concentrations in the high concentration core of the Southwest Plume. If more than one discrete area of greater than 1000 µg/L is present as a result of multiple source areas, then a permanent MW will be installed near the west plant security fence to monitor changes in contaminant concentrations in each high concentration core of the Southwest Plume. The well or wells will be screened at the depth where the highest VOC concentrations were measured in the temporary borings. Based on current interpretation of the TCE concentrations in the Southwest Plume, up to three MWs are planned for installation.

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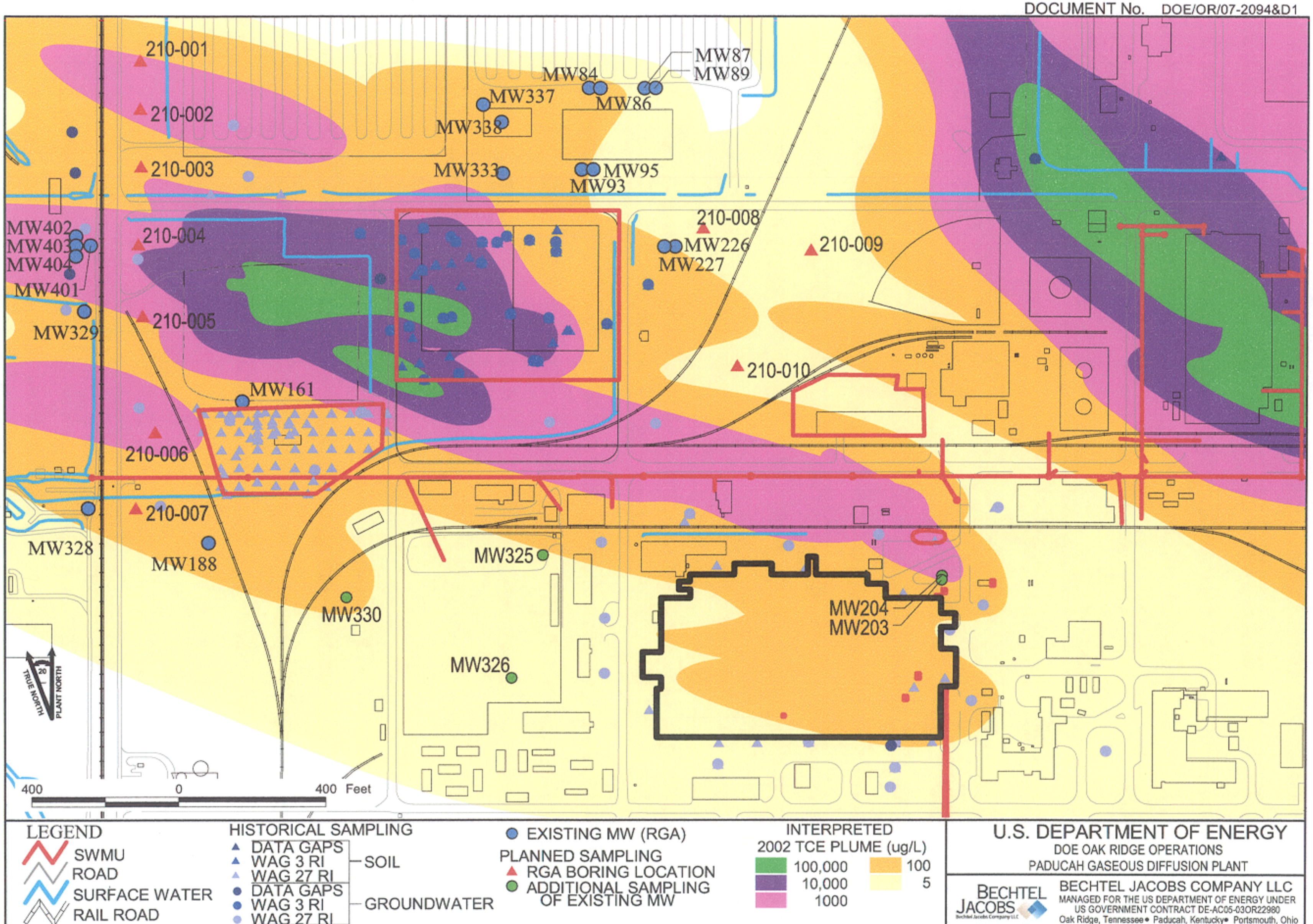

Fig. 9. Southwest Plume dissolved phase historical and planned sampling.

FIGURE No. c5ac90001sk652r2.apr
DATE 09-22-03

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Table 5. Summary of groundwater sampling and analysis for the dissolved phase portion of the Southwest Plume - SWMU 210

Boring	Drilling Method	Planned Total Depth (ft)	Sample Depth (ft bgs)	Media	Analytes
Planned					
210-001	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
210-002	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
210-003	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
210-004	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
210-005	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
210-006	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
210-007	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
210-008	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
210-009	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
210-010	DWRC/Sonic/HSA	100'	60', 70', 80', 90', 100'	Groundwater	VOCs, ^{99}Tc
Total Planned - 10		1000'	50 samples		
Contingency - None					
Monitoring Wells (MWs)					
MW84	RGA Well		(C-404 Well)	Groundwater	VOCs, Metals, Rad
MW86	RGA Well		(C-404 Well)	Groundwater	VOCs, Metals, Rad
MW87	RGA Well		(C-404 Well)	Groundwater	VOCs, Metals, Rad
MW89	RGA Well		(C-404 Well)	Groundwater	VOCs, Metals, Rad
MW93	RGA Well		(C-404 Well)	Groundwater	VOCs, Metals, Rad
MW95	RGA Well		(C-404 Well)	Groundwater	VOCs, Metals, Rad
MW161	RGA Well			Groundwater	VOCs, Metals, Rad
MW188	RGA Well			Groundwater	VOCs, Metals, Rad
MW203	RGA Well			Groundwater	VOCs, Metals, Rad
MW226	RGA Well		(C-404 Well)	Groundwater	VOCs, Metals, Rad
MW227	RGA Well		(C-404 Well)	Groundwater	VOCs, Metals, Rad
MW325	RGA Well			Groundwater	VOCs, Metals, Rad
MW326	RGA Well			Groundwater	VOCs, Metals, Rad
MW328	RGA Well			Groundwater	VOCs, Metals, Rad
MW329	RGA Well			Groundwater	VOCs, Metals, Rad
MW330	RGA Well			Groundwater	VOCs, Metals, Rad
MW333	RGA Well		(SWMU 002 Well)	Groundwater	VOCs, Metals, Rad
MW337	RGA Well		(SWMU 002 Well)	Groundwater	VOCs, Metals, Rad
MW338	RGA Well		(SWMU 002 Well)	Groundwater	VOCs, Metals, Rad
MW354	RGA Well			Groundwater	VOCs, Metals, Rad
MW401	RGA Well		(PTZ Well)	Groundwater	VOCs, Metals, Rad
MW402	RGA Well		(PTZ Well)	Groundwater	VOCs, Metals, Rad
MW403	RGA Well		(PTZ Well)	Groundwater	VOCs, Metals, Rad
MW404	RGA Well		(PTZ Well)	Groundwater	VOCs, Metals, Rad

Ft = feet
DWRC = dual-wall reverse circulation
^{99}Tc = technetium-99
bgs = below ground surface
VOCs = volatile organic compounds
RGA = Regional Gravel Aquifer
HSA = hallow-stem auger
SWMU = solid waste management unit
PTZ = Permeable Treatment Zone
Rad = Total uranium (U), ^{234}U, ^{235}U, ^{238}U, neptunium-237, plutonium-239, ^{99}Tc, Gross Alpha, and Gross Beta

2.4 FIELDWORK AND SAMPLING PROCEDURES

All fieldwork and sampling at PGDP will be conducted in accordance with approved medium-specific work instructions or procedures consistent with the *U.S. Environmental Protection Agency (EPA), Region IV, Standard Operating Procedures* revised last in 1996. DOE and its Prime Contractor will approve any deviations from these work instructions and procedures. The Prime Contractor will document all changes on a Field Change Request form as detailed in the QAPP (BJC 2003c). Table 6 provides a list of investigation activities for the Southwest Plume SI that may require work instructions or procedures for guidance.

Table 6. Fieldwork and sampling procedures

Investigation Activity
Use of Field Logbooks
Lithologic Logging
Labeling, Packaging, and Shipping of Environmental Field Samples
Groundwater Sampling Procedures: Water Level Measurements
Monitoring Well Purging and Groundwater Sampling
Filter Pack and Screen Selection for Wells and Piezometers
Monitoring Well Installation
Monitoring Well Development
Field Measurement Procedures: pH, Temperature, and Conductivity
Field Measurement Procedures: Dissolved Oxygen
Sampling of Containerized Wastes
Opening Containerized Waste
On-site Handling and Disposal of Waste Materials
Identification and Management of Waste Not From A Radioactive Material Management Area
Paducah Contractor Records Management Program
Quality Assured Data
Chain-of-Custody
Field Quality Control
Data Management Coordination
Equipment Decontamination
Off-site Decontamination Pad Operating Procedures
Cleaning and Decontaminating Sample Containers and Sampling Equipment
Environmental Radiological Screening
Pumping Liquid Wastes into Tankers
Archival of Environmental Data Within the ER Program
Data Entry
Data Validation
Well and Temporary Boring Abandonment
Field Measurement Procedures: Eh (Oxidation Reduction Potential)

2.4.1 Drilling Methods

The following sections briefly describe each of the three drilling methods suggested for use for the Southwest Plume SI. The MIP sampling system also is described.

Dual-Wall Reverse Circulation

DWRC is an air rotary drilling method using two concentric strings of drill pipe. In traditional air rotary drilling, the air travels through the center of the drill pipe, exits the bit, and returns to the surface by way of the annulus between the borehole wall and the drill pipe. The DWRC method is different from air rotary drilling in that the air used to lift the drill cuttings to the surface goes down the annulus between the two strings of drill pipe, exits at or near the drill bit, and returns to the surface through the center of the drill pipe. The drill bit is only slightly larger in diameter than the outer diameter of the outer drill string, resulting in almost no annular space between the drill pipe and the borehole wall. This minimal annular space and the reverse circulation of air that prevents contact of the air with the wall of the boring results in little opportunity for cross-contamination. The upward velocity of the air returning to the surface with the drill cuttings is on the order of 100 ft per second, which means that drill cuttings caught at the outlet of the air discharge cyclone are representative of the sediments at the face of the drill bit.

When an interval for water sampling is identified, rotary drilling stops, but air circulation is maintained for a brief period to clear the hole of cuttings. After air circulation stops, water from the sample interval enters the drill pipe through the bit, allowing collection of the water sample in the protected environment of the drill pipe. The speed at which water enters the drill pipe and reaches a static water level is an indication of the hydraulic conductivity of the interval being sampled. The faster the water level stabilizes, the greater the hydraulic conductivity. Because some warm air may enter the interval being sampled, purging prior to sampling is recommended. Water temperature and dissolved oxygen, in particular, should be monitored during purging. When these return to *in situ* values, water samples may be collected. Sampling may be done using a bladder pump suitable for a 2-inch MW.

Waste generation consists of drill cuttings and water. Drill cutting volumes are near theoretical hole size, since the air circulation does not erode the borehole wall. The volume of water produced is dependent on the productive capacity of the sediments. Aquifers capable of producing large volumes of water can result in significant wastewater volumes.

DWRC drilling has been used for groundwater characterization at PGDP in the Phase IV Investigation; the Northeast Plume Interim Remedial Action; the WAG 6, WAG 27, WAG 28, and WAG 3 RIs; and the "Data Gaps" investigation.

Rotary Sonic

Like DWRC, rotary sonic drilling uses two concentric strings of drill pipe with a drill bit designed to create minimal annular space between the drill pipe and borehole wall. Like DWRC, this configuration virtually eliminates vertical cross-contamination. Water sampling, using the same methodology, also takes place within the protected environment of the drill pipe where water from the interval being sampled enters the drill pipe through the drill bit. The primary differences are the method by which the drill string is advanced and the removal of the drill cuttings.

Rotary sonic drilling uses a combination of rotational movement and sonic resonance, which vibrates the drill string down through the sediments. The vibratory motion displaces the sediments laterally. The sediments near the outside of the drill string are pushed to the side of the borehole, while the sediments nearer the center of the drill string are captured as a core in a sleeve in the inner string of drill pipe. This drilling method results in a continuous core of sediments from the surface to the total depth of the hole as a natural by-product of the drilling process, rather than as an extra step requiring special equipment.

Rotary sonic drilling can install larger diameter MWs, such as the 4-inch wells recently installed at the C-746-S&T Landfill, without requiring the installation of protective casing from the surface to the top of the RGA. This is because the inner drill pipe can be withdrawn prior to well installation, leaving the outer drill pipe in place as a temporary protective casing. The MW then is built inside the outer drill pipe, as the outer drill pipe is withdrawn from the hole. A smaller hole diameter is required and less well material is required compared to wells installed using hollow stem augers.

Waste generation consists of the soil core and water. Drill cutting volumes are near theoretical hole size since only the soils in the core sleeve are recovered at the surface. Potable water often is used while drilling above the water table to reduce friction and to help displace drill cuttings and may return to the surface as wastewater. The volume of purge water produced is dependent on how much water is used during drilling and how quickly groundwater parameters return to *in situ* conditions after drilling stops.

Rotary sonic drilling has been used during the WAG 6 RI and the Site 3A Seismic Investigation.

Hollow Stem Auger/ Direct Push Combination

The HSA/DPT combination uses traditional hollow stem auger drilling combined with a direct push groundwater sampling assembly. The augers, fitted with a temporary plate at the face of the bit to prevent the entry of cuttings, are used to drill to approximately 5 ft above the interval to be sampled. A DPT groundwater sampling assembly is lowered inside the augers to the temporary plate. Then the DPT assembly is pushed or hammered through the temporary plate and into the sediments below the auger bit to the sample depth.

When the drive point sampler has reached the target depth, the mechanism allowing collection of a groundwater sample will be activated. Groundwater will be pumped to the surface, typically with an inertial pump or mechanical bladder pump, although some air- or inert gas-driven systems are available. A small amount of water, typically less than a gallon, will be purged to reduce the initial turbidity of the water sample. After purging, groundwater samples will be collected for analysis for VOCs, including TCE and its degradation products, and ^{99}Tc. During each sampling event, the field parameters of depth to water, groundwater temperature, pH, specific conductance, Eh, and dissolved oxygen will be collected.

After the groundwater sample is recovered, the DPT assembly is withdrawn; the augers are recovered, fitted with a new temporary plate, run back into the hole, and the hole is deepened to within 5 ft of the next groundwater sample interval.

Membrane Interface Probe

The MIP is not a drilling method, but a real-time VOC profiling and sampling method. The MIP uses a heating element and gas permeable membrane. The element heats the material surrounding the probe, causing the VOCs contained in the material to vaporize. The vapors enter the probe through a gas permeable membrane and are transported through tubing to the surface by an inert carrier gas. The sample then is analyzed in the field with equipment appropriate to the needs of the investigation. If just the detection of VOCs is important, then a simple PID is all that is required. If a qualitative estimate of VOC concentration with depth is needed, then an electron capture detector system may be deployed. When quantitative analysis of individual VOC species is needed, the surface analytical equipment consists of a GC/MS, DSITMS, or photoacoustic analyzer. The system is based on DPT methods, but could be deployed within a DWRC or rotary sonic boring. If the MIP is used to collect VOC samples, more traditional sampling methods will be required to collect samples for field parameters and ^{99}Tc analysis.

2.4.2 Boring Abandonment

After all the sampling in each boring is completed, the boring will be plugged and abandoned. Boring abandonment will be consistent with Commonwealth of Kentucky requirements and approved site procedures. The following bullets are a synopsis of the process.

- As the drill pipe or augers are withdrawn from the hole, fine-grained sand (size) will be added to the hole by tremie pipe, allowing sufficient time for the sand to settle.
- The sand column should extend from the bottom of the boring to the top of the RGA.
- When sand placement has reached the top of the RGA, a 2 to 4-ft bentonite pellet seal will be placed at the top of the sand. Hydration time will be according to manufacturer's specifications.
- After hydration of the seal, as withdrawal of the drill pipe or augers continues, the remainder of the hole will be filled with high-solids bentonite grout, using a tremie pipe, to within 18 inches of the ground surface.
- Once the rig is moved off the hole, the area around the boring will be roped off for safety.
- After 24 hours, the grout level will be checked and additional grout added, if necessary.
- When the grout level has stabilized, the remaining 18 inches of the hole will be filled with soil to ground level, and a stake will be placed with the boring number so that the location of the boring may be surveyed.

2.4.3 Requirements

All borings will be installed and abandoned by a licensed and certified driller in the Commonwealth of Kentucky or a driller working under a licensed and certified driller in the Commonwealth of Kentucky. Upon completion of abandonment of each boring, the Kentucky Certified Driller will submit the Kentucky Well Abandonment Report to the Commonwealth of Kentucky in compliance with his/her certification.

2.5 DOCUMENTATION

Field documentation will be maintained throughout the Southwest Plume SI in various types of documents and formats, including the field logbooks, sample labels, sample tags, chain-of-custody (COC) forms, and field data sheets. The following general guidelines for maintaining field documentation will be implemented. Additional information is contained in the Data Management Implementation Plan for this SI Work Plan (BJC 2003d). All entries will be written clearly and legibly using indelible ink.

- Corrections will be made by striking through the error with a single line that does not obliterate the original entry. Corrections will be dated and initialed.
- Dates and times will be recorded using the format "mm/dd/yy" for the date and the military (i.e., 24-hr) clock to record the time.
- Zeroes will be recorded with a slash (/) to distinguish them from letter Os.
- Blank lines are prohibited. Information should be recorded on each line or the line should be lined out, initialed, and dated.

- No documents will be altered, destroyed, or discarded even if they are illegible or contain inaccuracies that require correction.
- All information blocks on field data forms will be completed or a line will be drawn through the unused section, and the area will be dated and initialed.
- Unused logbook pages will be marked with a diagonal line drawn from corner to corner and a signature and date must be placed on the line.
- Security of all logbooks will be maintained by storing them in a secured (e.g., locked) area when not in use.
- Photocopies of all logbooks, field data sheets, and COC forms will be made weekly and sent to the project file.

2.5.1 Field Logbooks

Field team personnel will use bound field logbooks with sequentially numbered pages for the maintenance of field records and for documenting any information pertinent to field activities. Field forms will be numbered sequentially or otherwise controlled. A designated field team member will record sampling activities and information from site exploration and observation in the field logbook. Field documentation will conform to approved procedures for use of field logbooks. An integral component of Quality Assurance/Quality Control (QA/QC) for the field activities will be the maintenance of accurate and complete field records and the collection of appropriate field data forms. The primary purpose of the logbook is to document each day's field activities; the personnel on each sampling team; and any administrative occurrences, conditions, or activities that may have affected the fieldwork or data quality of any environmental samples for any given day. The level of detail of the information recorded in the field logbook should be such that an accurate reconstruction of the field events can be created from the logbook. The project name, logbook number, client, contract number, task number, document control number, activity or site name, and the start and completion dates will be listed on each logbook's front cover. Important phone numbers, radio call numbers, emergency contacts, and a return address should be recorded on the inside of the front cover.

2.5.2 Sample Log Sheets

A sample log sheet will contain sample-specific information for each field sample collected, including field QC samples. Generally, sample log sheets will be preprinted from the data management system with the following information:

- name of sampler;
- project name and number;
- sample identification number;
- sampling location, station code, and description;
- sample medium or media;
- sample collection date;
- sample collection device;
- sample visual description;
- collection procedure;
- sample type;
- analysis; and
- preservative.

In addition, all specific analytical requests will be preprinted from the data management system and will include the following for each analytical request:

- analysis/method,
- container type,
- number of containers,
- container volume,
- preservative (type/volume), and
- destination laboratory.

During sample collection, a field team member will record the remaining required information and will sign and date each sample log sheet. The following information will be recorded for each sample:

- whether or not the sample was collected;
- the date and time of collection;
- the name of the collector;
- collection methods and/or procedures;
- all required field measurements and measurement units;
- instrumentation documentation, including the date of last calibration;
- adherence to or deviation from the procedure and the SI Work Plan;
- weather conditions at the time of sample collection;
- activities in the area that could impact subsequent data evaluation;
- general field observations that could assist in subsequent data evaluation;
- lot number of the sample containers used during sample collection;
- sample documentation and transportation information, including unique COC form number, air bill number, and container lot number; and
- all relevant and associated field QC samples (for each sample).

If preprinted sample log sheets are not used, all information will be recorded manually. A member of the field sampling team (other than the recorder) will perform a QA review of each sample log sheet and document the review by signing and dating the log sheet. Notations of deviations will be initialed by the Field Operations Manager as part of his/her review of the logbook.

2.5.3 Field Data Sheets

Field data sheets will be maintained, as appropriate, for the following types of data:

- water level measurements,
- soil boring logs,
- MW construction logs,
- sample log sheets,
- well development logs,
- well purging logs,
- groundwater sampling logs,

- COCs,
- instrument calibration logs, and
- temperature monitoring sheets.

Data to be recorded will include such information as the location, sampling depth, sampling station, and applicable sample analysis to be conducted. Field-generated data forms will be prepared, if necessary, based on the appropriate requirements. The same information may be included in the field logbook or, if not, the field logbook should reference the field data sheet. If preprinted field data sheets are not used, all information will be recorded manually in the field logbook.

2.5.4 Sample Identification, Numbering, and Labeling

In addition to field logbooks and field data sheets, the sampling team will use labels to track sample holding times, ensure sample traceability, and initiate the COC record for the environmental samples. A pressure-sensitive gummed label will be secured to each sample container at the time of collection, including duplicates and trip or field blanks, at or before the completion of collection of that sample. Sample labels will be waterproof or will be sealed to the sample container with clear acetate tape after all information has been written on the label. Generally, sample labels will be preprinted with information from the data management system and will contain the following information:

- station name,
- sample identification number,
- sample matrix,
- sample type (grab or composite),
- type or types of analysis required,
- sample preservation (if required), and
- destination laboratory.

A field sampling team member will complete the remaining information during sample collection including these items:

- date and time of collection, and
- initials of sampler.

The sample numbers will be recorded in the field logbook along with the time of collection and descriptive information previously discussed.

The sample identification protocol is outlined as follows:

sssnnnMA000

where

sss	identifies the SWMU being investigated;
nnn	identifies the sequential boring number (according to the same numbering scheme, sss-nnn identifies the location name);
M	identifies the media type (W identifies the sample as groundwater, S identifies the sample as soil);
A	identifies the sequential sample (usually "A" for a primary sample and "B" for a secondary sample); and
000	identifies the planned depth of the sample in ft bgs.

2.5.5 Sample COC

COC procedures will document sample possession from the time of collection, through all transfers of custody, to receipt at the laboratory and subsequent analysis. COC records will accompany each packaged lot of samples; the laboratory will not analyze samples that are not accompanied by a correctly prepared COC record. A sample will be considered under custody if it is (1) in the possession of the sampling team, (2) in view of the sampling team, or (3) transferred to a secured (i.e., locked) location.

COC records will follow the requirements as specified in a DOE Prime Contractor-approved procedure for keeping the records. This form will be used to collect and track samples from collection until transfer to the laboratory. Copies of the signed COCs will be faxed or delivered to the DOE Prime Contractor Sample Management Office (SMO) within three days of sample delivery.

The Sampling Team Leader is responsible for reviewing and ensuring the accuracy and completeness of the COC form and for the custody of samples in the field until they have been properly transferred to the Sample Coordinator. He or she is responsible for sample custody until the samples are properly packaged, documented, and released to a courier or directly to the analytical laboratory. If samples are not immediately transported to the analytical laboratory, they will remain in the custody of the Sample Coordinator where they will be refrigerated and secured either by locking the refrigerator or by placing custody seals on the individual containers.

Each COC form will be identified by a unique number located in the upper-right corner, recorded on the sample log sheet at the time of sample collection. The laboratory COC will be the "official" custody record for the samples. Each COC form will contain the following information:

- the sample identification for each sample;
- collection data for each sample;
- number of containers of each sample;
- description of each sample (i.e., environmental matrix/field QC type);
- analyses required for each sample; and
- blocks to be signed as custody is transferred from one individual to another.

The airbill number will be recorded on the COC form if applicable. The laboratory COC form will be sealed in a resealable plastic bag and taped to the inside of the cooler lid if the samples are to be shipped off-site. A copy will be retained in the laboratory, and the original will be returned to the Sample Manager with the completed data packages.

At each point of transfer, the individuals relinquishing and receiving custody of the samples will sign in the appropriate blocks and record the date and time of transfer. When the laboratory sample custodian receives the samples, he or she will document receipt of the samples, record the time and date of receipt, and note the condition of the samples (e.g., cooler temperature, whether the seals are intact) in the comments section. The laboratory then will forward appropriate information to the Sample Manager. This information may include the following:

- a cover memo stating sample receipt date and any problems noted at the time of receipt; and
- a report showing the field sample identification number, the laboratory identification number, and the analyses scheduled by the laboratory for each sample.

2.5.6 Sample Shipment

Aliquots of investigative samples will be screened by an on-site laboratory before shipment to an off-site laboratory. Results from the screening process will be recorded in Paducah's Project Environmental Measurements System (Paducah PEMS) and will be reviewed prior to preparation for sample shipment off-site. Sample containers will be placed in the shipping container and packed with ice and absorbent packing for liquids. The completed COC form will be placed inside the shipping container unless otherwise noted. The container then will be sealed. In general, sample containers will be packed according to the following procedures.

- Glass sample containers will be wrapped in plastic insulating material to prevent contact with other sample containers or the inner walls of the container.
- Logbook entries, sample tags and labels, and COC forms will be completed with sample data collection information and names of all persons handling the sample in the field before packaging.
- Samples, temperature blanks, and trip blanks will be placed in a thermally-insulated cooler along with ice that is packed in resealable plastic bags. After the cooler is filled, the appropriate COC form will be placed in the cooler in a resealable plastic bag attached to the inside of the cooler lid.
- Samples will be classified according to U.S. Department of Transportation (DOT) regulations pursuant to 49 *CFR* 173. All samples will be screened for radioactivity to ensure that DOT limits of 2.0 nCi/ml of liquid waste and 2.0 nCi/g for solid waste are not exceeded.

2.5.7 Field Planning Meeting

A field-planning meeting will occur before work begins at the site so that all involved personnel will be informed of the requirements of the fieldwork associated with the project. Additional planning meetings will be held whenever new personnel join the field team or if the scope of work changes significantly. Each meeting will have a written agenda and attendees must sign an attendance sheet, which will be maintained on-site and in the project files. The following topics will be discussed at these meetings:

- project- and site-specific health and safety,
- objectives and scope of the fieldwork,
- equipment and training requirements,
- procedures,
- required QC measures, and
- documents covering on-site fieldwork.

2.5.8 Readiness Checklist

Before implementation of the field program, all project personnel will review the work control documents to identify all field activities and materials required to complete the activities, including:

- task deliverables,
- required approvals and permits,
- personnel availability,
- training,
- field equipment,
- sampling equipment,

APPENDIX

SCOPING MEETING NOTES – JUNE 24, 2003

MEETING NOTES

SCOPING PRESENTATION FOR THE SOUTHWEST PLUME AT THE PADUCAH GASEOUS DIFFUSION PLANT

June 24, 2003

Attendees

Tuss Taylor, KDEP
Brian Begley, KDEP
Todd Mullins, KDEP
Janet Miller, KDEP
Gaye Brewer, KDEP
Steve Hampson, UK-KYRCB
Christopher Potter, Garrett Fleming
Gary Bodenstein, DOE
John Sheppard, DOE
Tom Wheeler, BJC
Larry Young, BJC
Rebecca Ausbrooks, BJC
Craig Jones, BJC
John Morgan, BJC
Rich Bonczek, SAIC
Eric Morti, SAIC
LeAnne Garner, SAIC

Introduction

On June 24, 2003, the Department of Energy (DOE) presented a scoping package for the Southwest Plume. Mr. Craig Jones introduced the meeting. The purpose for the project is a result of a milestone that was agreed upon among the principals (DOE, U.S. Environmental Protection Agency [EPA], and Kentucky Department for Environmental Protection [KDEP]). Its focus is to address sources and dissolved-phase plume. Questions were asked as to why we are thinking of addressing sources now. Previously we have addressed only the plume. Mr. John Morgan stated that under the C-720 and Solid Waste Management Unit (SWMU) 1 Record of Decision (ROD), actions would not address the major source (potentially SWMU 4).

Mr. Rich Bonczek presented the background portion of the scoping presentation (slides 1 through 20). The slides for the scoping presentation are attached to these Meeting Notes. He explained differences in MEPAS modeling and SESOIL/AT123D modeling and their purposes. He stated that the differences between the two modeling approaches mainly show uncertainty.

Slides 21 through 24 present conceptual models for the investigation areas. Slide 21 presents the conceptual model of SWMU 1, as shown in the Waste Area Group (WAG) 27 Remedial Investigation (RI) Report. The figure shows dense non-aqueous phase liquid (DNAPL) source in the Regional Gravel Aquifer (RGA). This is not the current interpretation in the Groundwater Operable Unit (OU) ROD. Currently it is believed that all the trichloroethene (TCE) is in the Upper Continental Recharge System (UCRS) with dissolved-phase percolating and going down. Mr. Todd Mullins agreed in later discussions. Slides 23 and 24 show flow-chart diagrams of the conceptual model. Mr. Bonczek stated that only subsurface soil and groundwater will be addressed in this investigation; all other pathways will be deferred to the appropriate OUs.

Response scenarios and throughout the presentation, all calculations are at the property boundary. KDEP always has held to the plant fence as the point of exposure. This point was noted.

Additionally, KDEP had questions about the source term definition and about the degradation of TCE used in the newer modeling [*Contaminant Migration from SWMU 1 and the C-720 Area at the PGDP* (BJC/PAD-506 February 2003)]. The resolution to this was that fate, transport, and a risk assessment would spin out of this project so that KDEP could approve or disapprove of the modeling used. Mr. Jones also agreed that technical justification regarding the new models (specifically the degradation) would be presented to KDEP.

Slides 25 through 27 were presented by Mr. Bonczek. These slides list likely response scenarios to primary sources, secondary sources, and dissolved-phase plumes.

Mr. Eric Morti presented the proposed sampling portion of the scoping meeting (slides 28 through 44). Discussion regarding the proposed sampling and resolutions is contained in the following sections.

Slides 45 and 46 list potential ARARs and to-be-considered(s) (TBCs), slide 47 contains a summary of the Southwest Plume scoping, and slide 48 shows the path forward.

SWMU 1 Sampling

Mr. Mullins stated that he felt there was no need to resample SWMU 1, as it is already swiss cheese. The data will be six years old, at the time of the proposed investigation, but it is good quality data, unlike Phase 1/Phase2. Since KDEP hasn't "bought off" on the Membrane Interface Probe (MIP), Mr. Jones agreed to provide KDEP MIP data from the Six-Phase Heating Treatability Study. Additionally, discrete sampling will be used as confirmation, the percentage of which will be proposed in the work plan. While planned sampling locations are biased to the more contaminated locations, depth intervals will be at pre-planned intervals to ensure a more statistically proportional selection.

After discussion about the number of samples, it was decided that five direct push technology (DPT)/MIP locations would be sampled, four on the outside and one in the middle (centered around the previous boring 001-165). Three DPT/MIP locations will be held as contingency (clear decision rules to be provided in the sampling and analysis plan). Discrete depth sampling at these locations will be analyzed at a fixed-base laboratory for volatile organic compounds (VOCs) only.

C-720 Area Sampling

Sampling currently is scoped to focus on the northeast corner. Proposed DPT/MIP sampling is in the area where cleaning of equipment reportedly took place (spacing of ~50'). Mr. Mullins would like to see some of these samples moved down to the southeast corner of C-720. Initially, three DPT/MIP locations put along the southern edge of the building, southeast side.

After discussion, it was decided six DPT/MIP locations (in a "U" shape) would be kept in the northeast corner of the building, and two DPT/MIP locations would be added to the southeast corner of the building. Two DPT/MIP locations may be used as contingency with clear decision rules to be provided in the sampling and analysis plan. Discrete depth sampling at these locations will be analyzed for VOCs, radionuclides, and metals.

In addition to DPT/MIP sampling at the C-720 area, five existing groundwater monitoring wells will be sampled and analyzed for VOCs, radionuclides, and metals.

Storm Sewer Sampling

Mr. Morti presented that the plan is to push the MIP to 20 ft with a contingency to push deeper (up to 60 ft) if contamination is found.

Several questions were asked about the 1985 TCE leak discovery and historic practices. Questions also were asked about the WAG 6 utility sampling. Questions were raised as to how the storm sewer video investigation will connect with an action on dissolved-phase plume and if the camera would work. Questions also were asked about the thickness of the bedding, depth of the pipe, thickness of the pipe, and slope of the pipe. Answers to these questions will be provided in the work plan.

After discussion, it was decided to complete at least 15 DPT/MIP locations, spaced along the sewer line, based upon camera investigation results. Clear decision rules will be presented in the sampling and analysis plan such that contingency DPT/MIP locations could be placed to raise the number to 30 or that the 20 ft depth could be increased to 60 ft. Discrete depth samples for the initial 15 DPT/MIP locations will be analyzed for VOCs only. Should contingency locations and/or depths be required, those discrete depth samples at those locations will be analyzed for VOCs, radionuclides, and metals.

SWMU 4

The goal for this portion of the investigation will be to determine if SWMU 4 still is releasing contaminants to the Southwest Plume. After discussion about the placement of the RGA borings, it was decided to moved the borings closer to the SWMU, placing them in the road if necessary. The total RGA borings for the area are four upgradient and five downgradient of the SWMU. Mr. Tuss Taylor agreed that if no volatiles were present, one could assume no metals would be present; therefore, groundwater samples from the borings would be analyzed for VOCs and ^{99}Tc only. One RGA monitoring well would be placed downgradient of SWMU 4, based on results from the RGA borings and screened in the upper portion of the aquifer.

Since additional modeling specific to SWMU 4 will not be completed for this investigation/action, soil data is not necessary. Therefore, the proposed DPT/MIP locations were deleted from the planned activities.

SW Plume (dissolved-phase area)

Transects of RGA borings are proposed to determine the width of the plume. RGA borings will provide five groundwater samples from discrete depths within the aquifer. One boring was added to the north in order to investigate the effects of channeling, and one will be placed to confirm permeable treatment zone multi-port monitoring well results. Samples from these borings will be analyzed for VOCs and ^{99}Tc only.

The three RGA borings initially located in a diagonal will be placed to consider the raw water line and to determine if there is significant water leakage along that area.

Two monitoring wells still are planned, but their locations have not been decided. Their placement will be determined, based on analytical results from the investigation and decision rules presented in the sampling and analysis plan.

Sampling Summary

Table 1 summarizes sampling currently planned. Additionally, the map on page 5 shows the modifications to the initial sampling plan.

Table 1. Sampling Summary, Revised.

	UCRS					RGA					Other Sampling
	DPTs (with MIP)			Soil Samples		Temporary RGA Borings			Groundwater Samples		
	Number	Estimated Depth	Total Footage	Number	Analyses	Number	Estimated Depth	Total Footage	Number	Analyses	
SWMU 1	5	60	300	20	VOCs	-	-	-	-	-	-
C-720 Area	8	60	480	32	VOCs,metals radionuclides	-	-	-	5	VOCs,metals radionuclides	-
SWMU 102 storm sewer	15	20	300	15	VOCs	-	-	-	-	-	Video camera storm sewer: 3000 linear ft
SWMU 4	-	-	-	-	-	9	100	900	45	VOCs, ^{99}Tc	Install 1 monitoring well
SW Plume	-	-	-	-	-	10	100	1000	45	VOCs, ^{99}Tc	Install up to 2 monitoring wells
Totals	28		1080	67		19		1900	95		
Contingency	20	60	1800*	125*	see note below						

NOTE: Analyses for contingency sampling will be the same as for the base sampling in all areas except SWMU 102 (storm sewer).

*Base sampling for the storm sewer area is to 20' with VOC analysis. Contingency sampling for the area includes an additional depth of the base locations for up to 60' bgs and analyses for VOCs, metals, and radionuclides. Additionally, up to 15 locations for up to 60' depth are held as contingency to be analyzed for VOCs, metals, and radionuclides.

Action Items

1. The location used for Point of Exposure/Point of Compliance is disputed: the disputed point is whether the plant fence or the DOE property boundary is used. Mr. Jones will communicate these concerns to higher levels of management within DOE, KDEP, and EPA for a decision.

2. New modeling used for the C-720 and SWMU 1 areas is in controversy. Additional technical justification and review will be made regarding TCE degradation rates and selection of data used in source term concentration calculations (i.e., use of non-detect results)

3. Website addresses for information regarding the MIP will be provided to the regulators. (A list of web addresses is attached, see page 6.)

4. Mr. Larry Young will ensure MIP data from the Six-Phase Heating Treatability Study is provided to the regulators for information.

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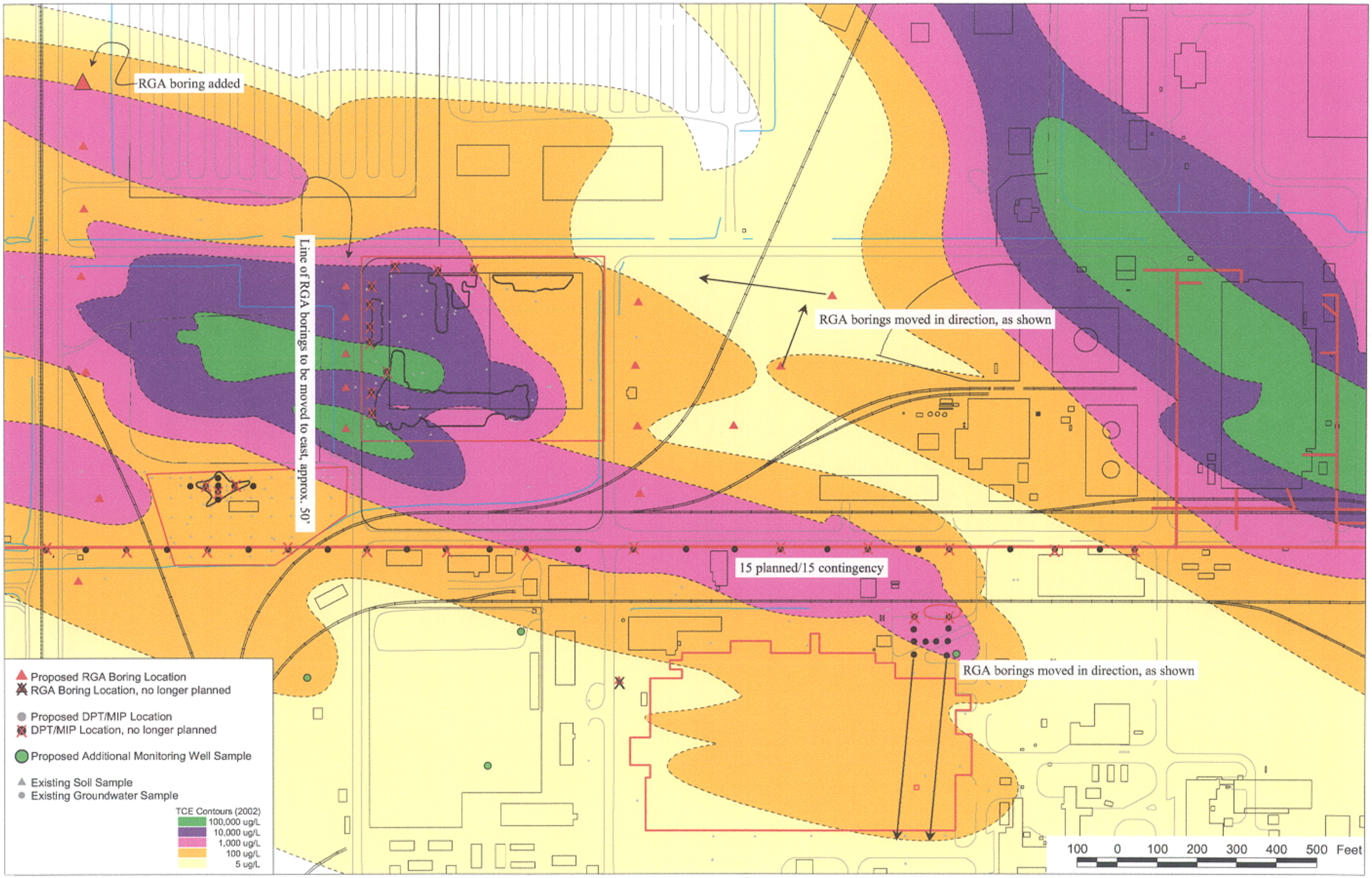

RGA boring added
Line of RGA borings to be moved to east, approx. 50'
RGA borings moved in direction, as shown
15 planned/15 contingency
RGA borings moved in direction, as shown
Proposed RGA Boring Location
RGA Boring Location, no longer planned
Proposed DPT/MIP Location
DPT/MIP Location, no longer planned
Proposed Additional Monitoring Well Sample
Existing Soil Sample
Existing Groundwater Sample
TCE Contours (2002)
100,000 ug/L
10,000 ug/L
1,000 ug/L
100 ug/L
5 ug/L
100 0 100 200 300 400 500 Feet

Membrane Interface Probe (MIP) References

http://www.containment.fsu.edu/cd/content/pdf/160.pdf
Real-time Site Characterization with the **Membrane Interface Probe**—*CH2M Hill case study of MIP application.*

http://enviro.nfesc.navy.mil/erb/erb_a/support/cleanup_conf/2001conf/2001cd/a37mip.ppt
Navy and Marine Corps Site Cleanup Conference February 2001 Conference Proceedings— *general description and case-studies of MIP use.*

http://www.hsweng.com/img/DNAPL%20Battelle.pdf
DNAPL SITE CHARACTERIZATION - A COMPARISON OF FIELD TECHNIQUES…—*comparison of various field techniques to evaluate chlorinated solvent DNAPL at NASA's Components Clean Facility.*

http://www.epa.gov/superfund/programs/siteasmt/symp03/pdfs/triad.pdf
Using Rapid Analytical Results for On Using Rapid Analytical...—*EPA's triad approach to site characterization.*

http://di.geoprobe.com/literature/mip_lit.htm
MIP Logging Product Sheet (189 KB .PDF)
MIP Logging SOP (714 KB .PDF)
MIP Logging Technical Paper by Thomas Christy, P.E. (500 KB .PDF)

http://www.columbiadata.com/mip/resources.cfm
A collection of papers and references for MIP.

http://www.estcp.org/documents/techdocs/199603-MIP.pdf
Tri-Service Site Characterization and Analysis Penetrometer System (SCAPS) Membrane Interface Probe—*Using a standard MIP with the high-tech SCAPS system.*

ATTACHMENT
PRESENTATION SLIDES

Scoping Presentation for the Southwest Plume at the PGDP

June 24, 2003

Paducah, Kentucky

Purpose of Southwest Plume Investigation

- To determine which units are sources of contamination to the Southwest Plume
- To determine which units are *not* sources of contamination to the Southwest Plume
- To fill data gaps for risk assessment of the identified source areas
- To reduce uncertainties and increase our understanding of the Southwest Plume and potential sources so that response actions can be identified

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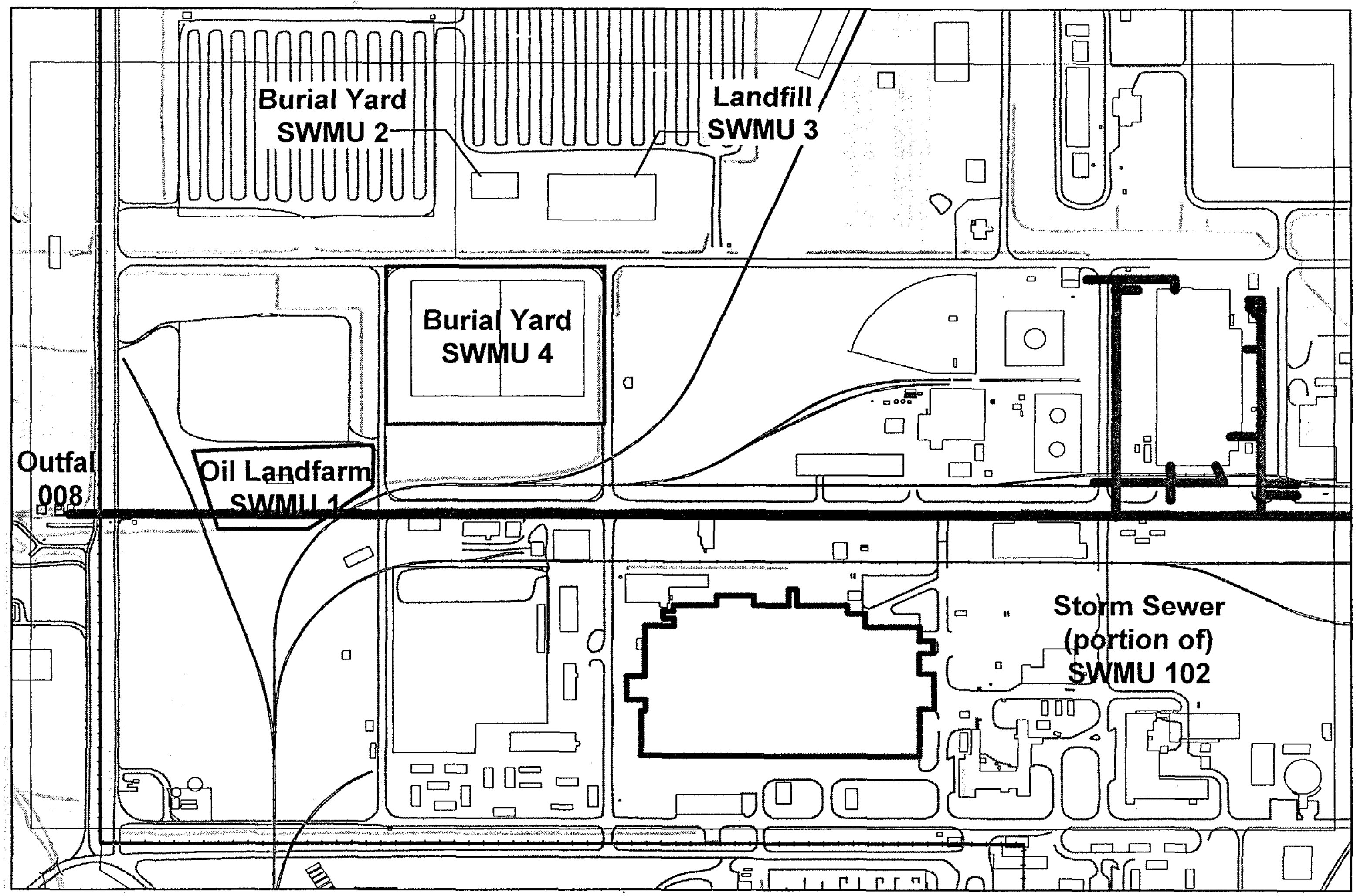
Potential Source Areas

- SWMU 1 (C-747-A Oil Landfarm)
- AOC 211 (C-720 TCE Spill Site Northeast) and SWMU 209 (C-720 Compressor Shop Pit Sump)
- SWMU 102 (plant storm sewer ~ C-400 to Outfall 008)
- SWMU 4 (C-747 Contaminated Burial Yard)

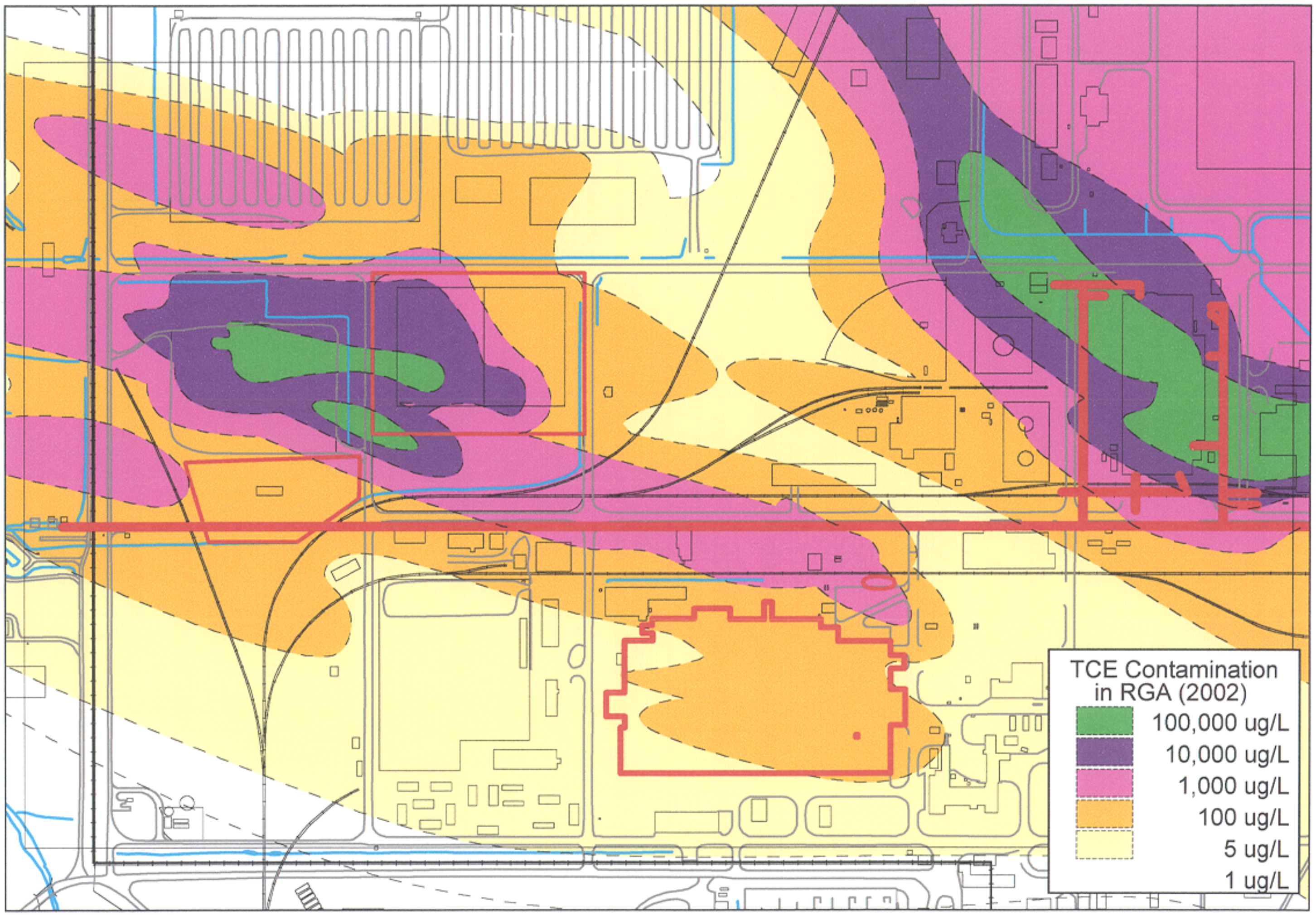
Other Potential Source Areas

- C-400 Cleaning Building
- SWMU 2 (C-749 Burial Ground)
- SWMU 3 (C-404 Landfill)

Area Map & Investigation Areas



Area Map & Investigation Areas



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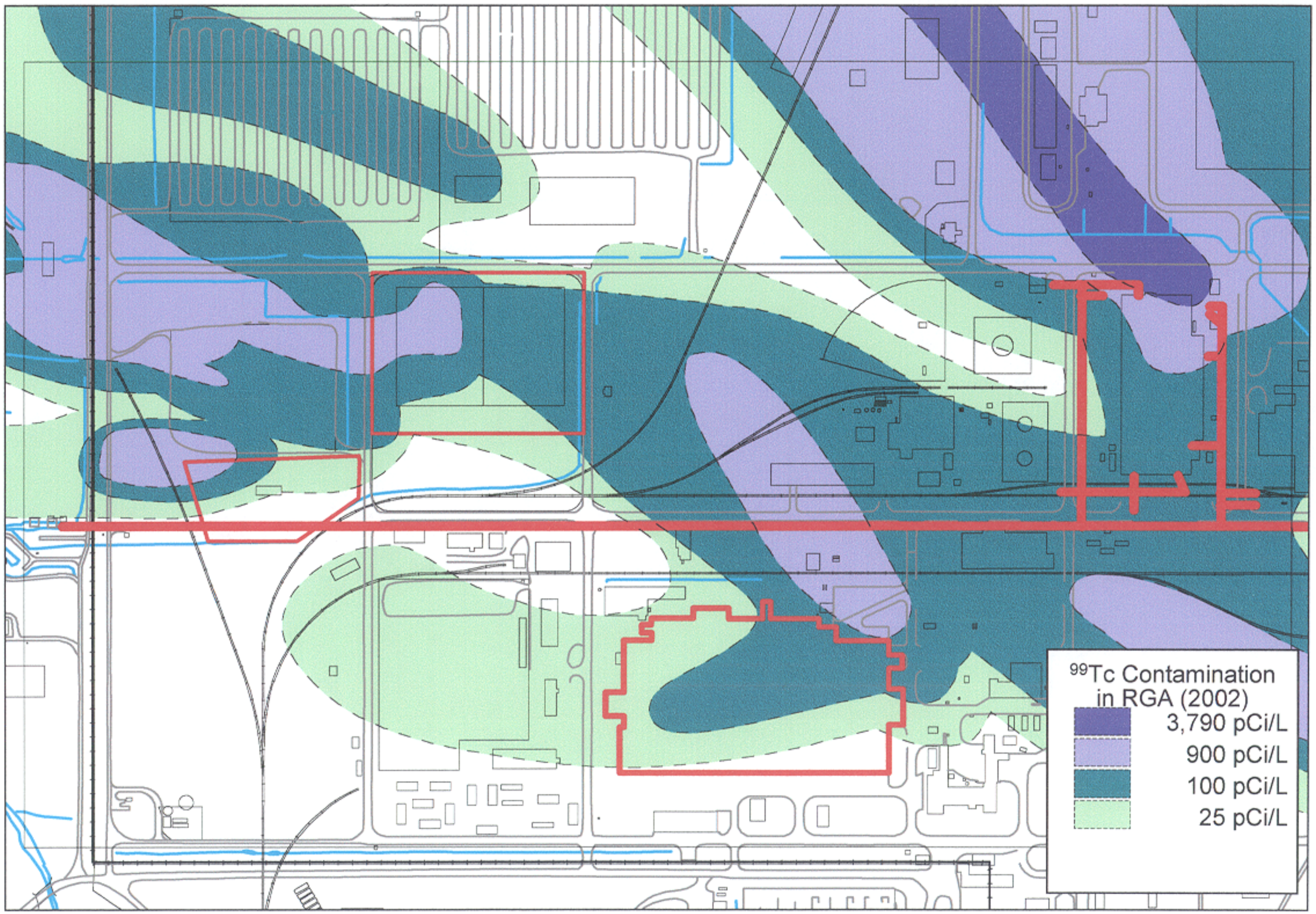
Area Map & Investigation Areas



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Scoping Package Contents

1. Existing data pertaining to the characteristics of the release(s) or potential release(s)
   - Previous investigations
   - Historical records

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2. Conceptual model of release(s)
   - Identify potential release and exposure pathways
   - Identify potential contaminants of concern
3. Identify likely response scenarios and applicability of presumptive remedies and innovative technologies

Scoping Package Contents

4. Identify need for limited data collection efforts to assist project scoping
5. Identify the type, quality, quantity of data to be collected
6. Initiate the identification of potential federal and state ARARs and, as appropriate, other criteria, advisories, or guidance to be considered

1. Existing Data

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Summary of Previous Investigations and Areas Investigated						
Date	**Title**	**SWMU 1**	**C-720**	**Storm Sewer**	**SWMU 4**	**SW Plume**
1989-1990	Phase I Site Investigation	✓		✓	✓	
1990-1991	Phase II Site Investigation	✓		✓	✓	
March 1996	Site-specific sampling	✓				
1997	WAG 6 Remedial Investigation			✓		
1998	WAG 27 Remedial Investigation	✓	✓		✓	✓
1999	Site-Wide Data Gaps Investigation				✓	✓
1999	Mega-WAG Remedial Investigation				✓	

1. Existing Data: SWMU 1

Fate and transport modeling results for SWMU 1
(MEPAS modeling results from 1999 WAG 27 RI Report)

	Property boundary	
Constituent	**Modeled Maximum Concentration (mg/L)**	**Time (year)**
	Subsurface Soil	
Antimony	0.0131	862
Beryllium[a]	0	10,000
bis(2-ethylhexyl)phthalate	0	10,000
Cadmium[a,b]	1.543E-34	9,974 to 15,696
Manganese	0.0263	2,643
TCE	**3.4**	**122**
Vinyl chloride	**0.0129**	**63**
Xylenes	0.0000186	171

[a] Receptor concentrations are zero over the given time range.

[b] Concentrations vary by less than 1/100th of 1% of the maximum concentration over the given time range (steady state).

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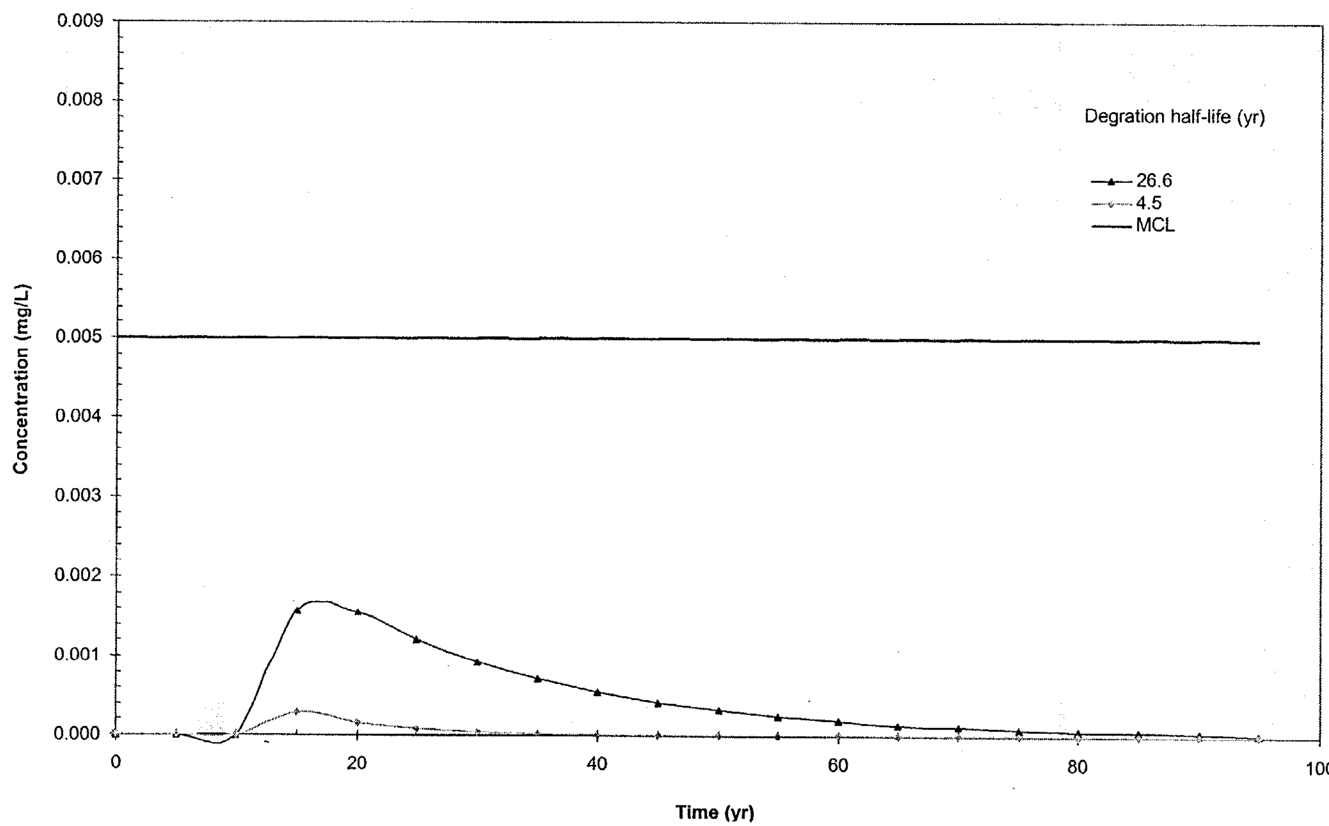
1. Existing Data: SWMU 1

SESOIL and AT123D Modeling Results for SWMU 1

Source: *Contaminant Migration from SWMU 1 and the C-720 Area at the PGDP* (BJC/PAD-506 dated February 2003)



Concentrations of TCE in groundwater at the DOE property boundary from migration from SWMU 1 source

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1. Existing Data: C-720 Area

Fate and transport modeling results for the C-720 Building

(MEPAS modeling results from 1999 WAG 27 RI Report)

	Property boundary	
Constituent	**Modeled Maximum Concentration (mg/L)**	**Time (year)**
	Subsurface Soil	
Antimony	0.0873	361
Bis(2-ethylhexy)phthalate[b]	5.14E-21	9,996 to 11,180
Beryllium[a,b]	0	10,000
Cadmium[b]	1.13E-19	9,959 to 10,723
Cobalt	0.0056	4,301
Copper	0.00324	9,974
Lead[a]	0	10,000
Silver	0.03	976
Thallium	0.8026	38
Trans-1,2-DCE	**2.83**	**30**
TCE	**0.535**	**82**
Vanadium	0.0077	6,039
Vinyl chloride	**0.0015**	**60**

[a] Receptor concentrations are zero over the given time range.

[b] Concentrations vary by less than 1/100th of 1% of the maximum concentration over the given time range (steady state).

1. Existing Data: C-720 Area

SESOIL and AT123D Modeling Results for C-720 Source Area 1 (southeast)

Source: *Contaminant Migration from SWMU 1 and the C-720 Area at the PGDP* (BJC/PAD-506 dated February 2003)

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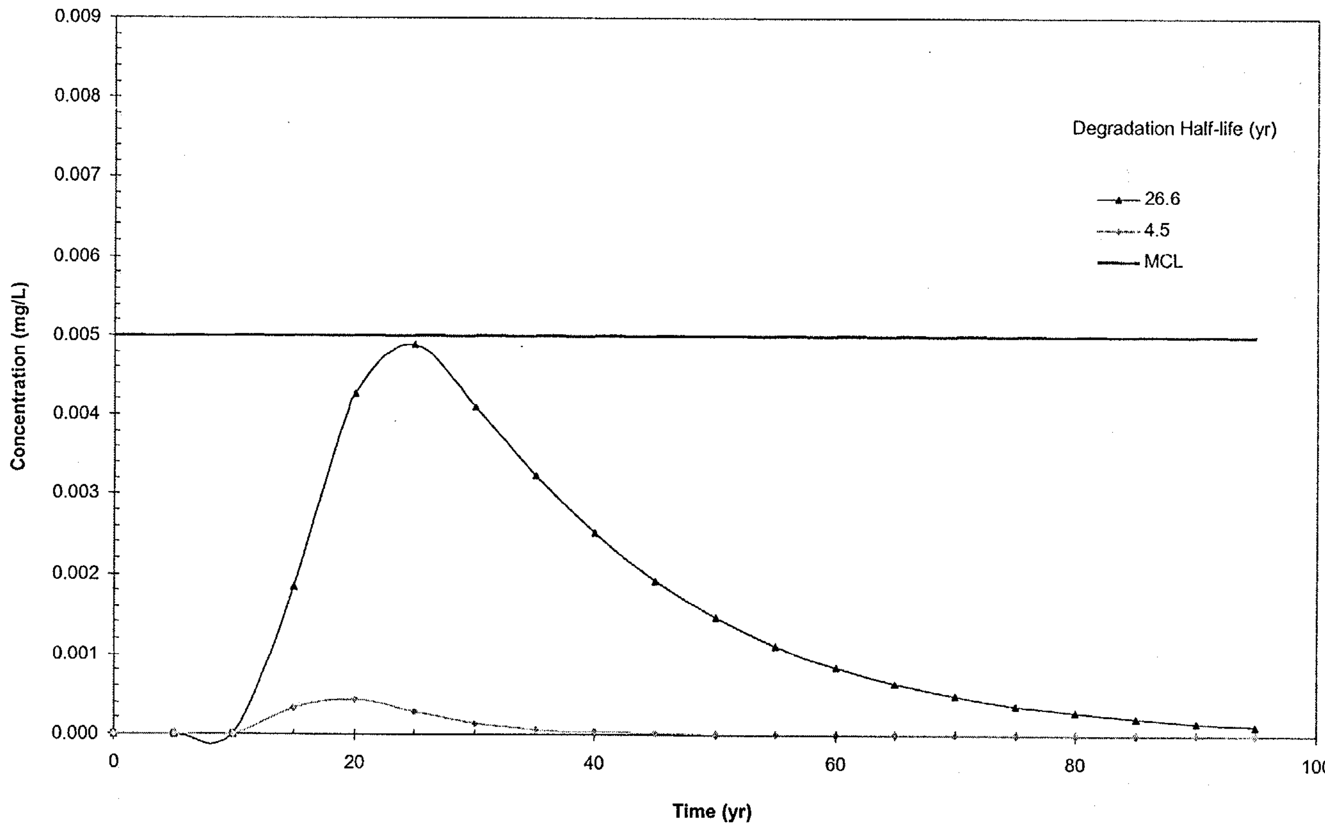
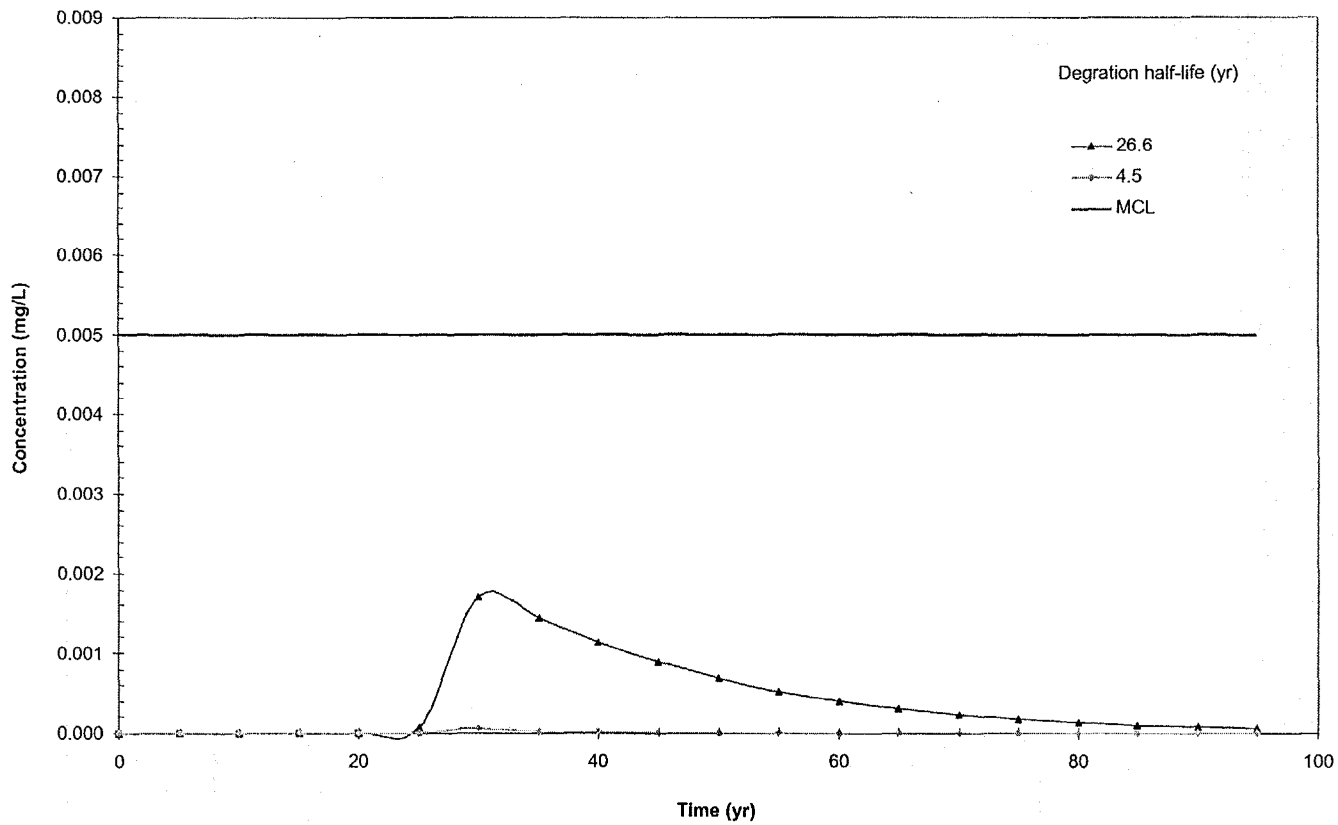


Concentrations of TCE in groundwater at the DOE property boundary from migration from C-720 Source Area 1

1. Existing Data: C-720 Area

SESOIL and AT123D Modeling Results for C-720 Source Area 2 (southwest)

Source: *Contaminant Migration from SWMU 1 and the C-720 Area at the PGDP* (BJC/PAD-506 dated February 2003)



Concentrations of TCE in groundwater at the DOE property boundary from migration from C-720 Source Area 2

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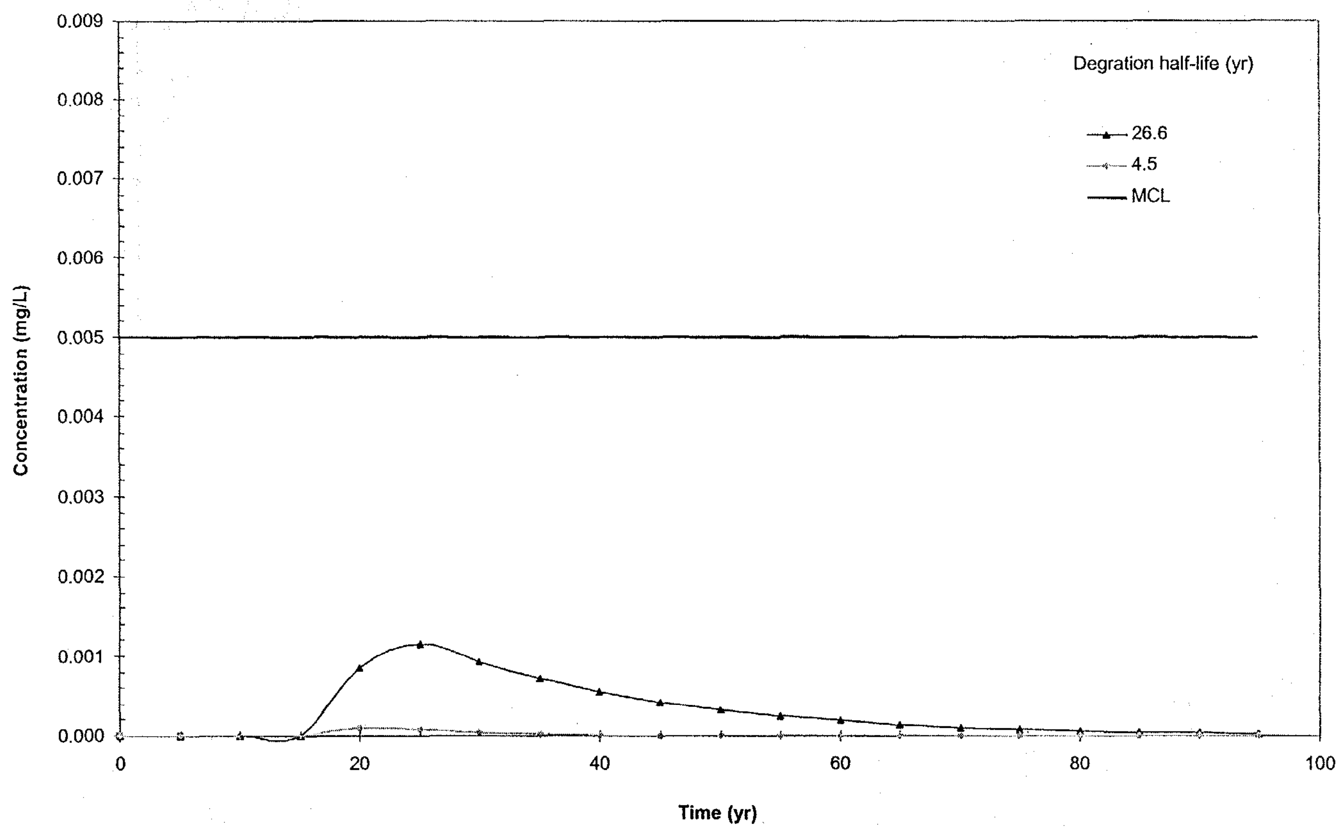
1. Existing Data: C-720 Area

SESOIL and AT123D Modeling Results for C-720 Source Area 3 (northwest)

Source: *Contaminant Migration from SWMU 1 and the C-720 Area at the PGDP* (BJC/PAD-506 dated February 2003)

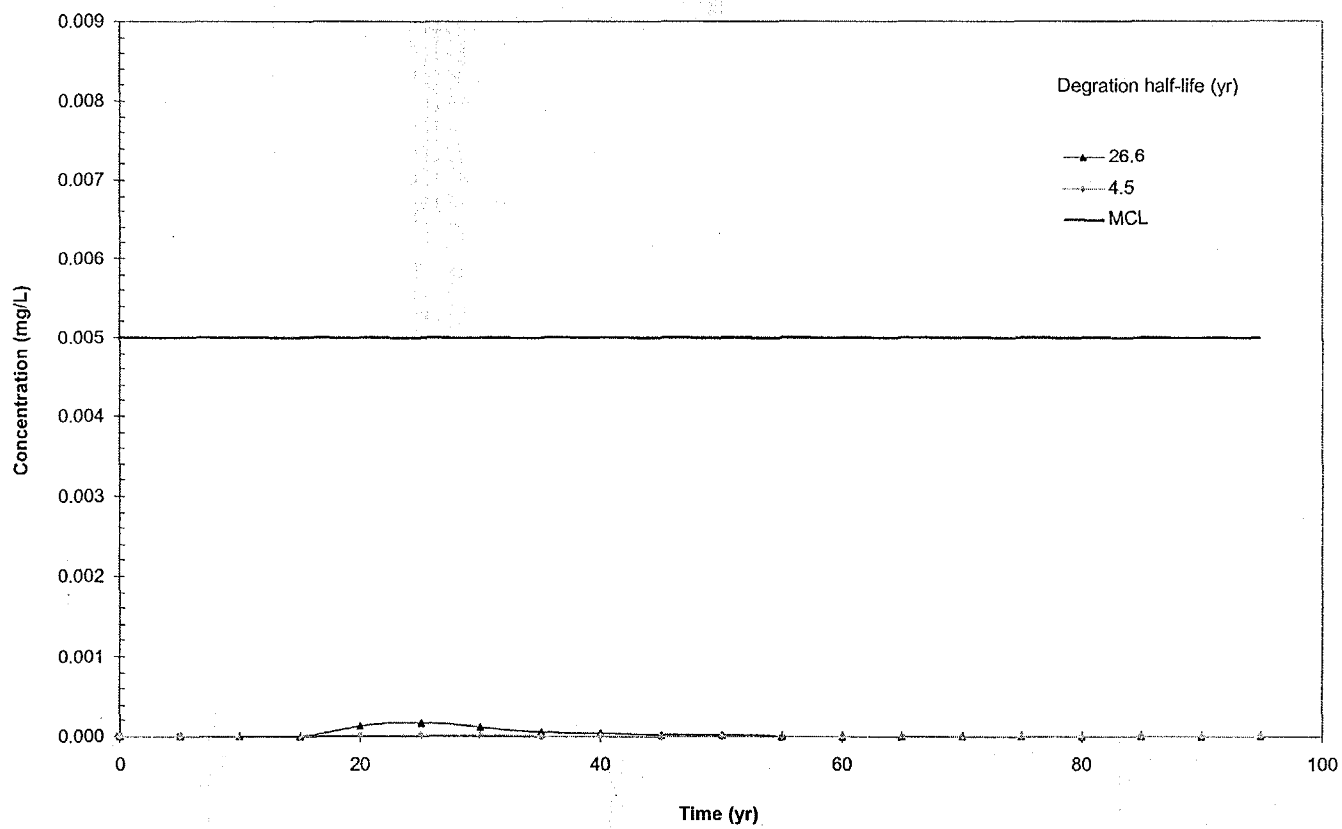


Concentrations of TCE in groundwater at the DOE property boundary from migration from C-720 Source Area 3

1. Existing Data: C-720 Area

SESOIL and AT123D Modeling Results for C-720 Source Area 4 (northeast)

Source: *Contaminant Migration from SWMU 1 and the C-720 Area at the PGDP* (BJC/PAD-506 dated February 2003)



Concentrations of TCE in groundwater at the DOE property boundary from migration from C-720 Source Area 4

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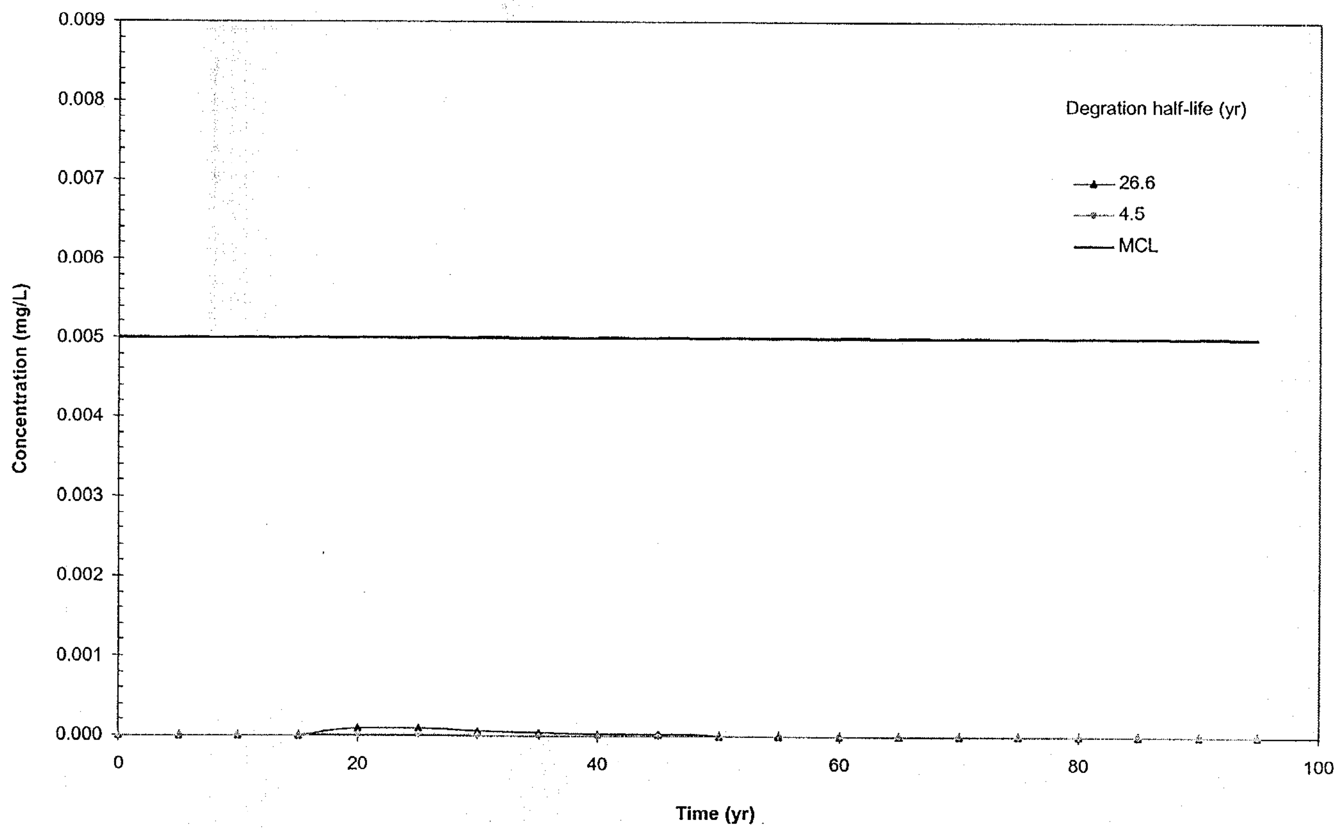
1. Existing Data: C-720 Area

SESOIL and AT123D Modeling Results for C-720 Source Area 5 (north)

Source: *Contaminant Migration from SWMU 1 and the C-720 Area at the PGDP* (BJC/PAD-506 dated February 2003)



Concentrations of TCE in groundwater at the DOE property boundary from migration from C-720 Source Area 5

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1. Existing Data: Storm Sewer

- SWMU 102: Storm Sewer
  - Sampling is limited, no risk assessments and no contaminant transport modeling have been completed for the sewer line.
  - Construction summary:
    - Feeder drains coming out of C-400 and south side field inlets are 12" and 15" vitreous clay pipe
    - Feeder drains tie to 24" and 30" reinforced concrete pipe secondary lines
    - Primary line to KPDES Outfall 008 is 60" reinforced concrete pipe
    - Bottom of sewer line is about 15 feet below ground surface.
    - Total distance from southwest corner of C-400 to Outfall 008 is approximately 3000 feet.

1. Existing Data: Storm Sewer

Storm Sewer Line Data

(Existing Analytical Data)

Constituent	Detected above MDL /Total analyzed	Max Detect (mg/kg)
	Soil	
TCE	7/73	0.19
1,1,1-TCA	7/44	0.015

Based on data collected within 50 ft of sewer line (100 ft study area) and west of 10th Street.

1. Existing Data: SWMU 4

Fate and transport modeling results for SWMU 4
(MEPAS modeling results from 2001 WAG 3 RI Report)

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Constituent	Property boundary Modeled Maximum Conc. or Activity (mg/L or pCi/L)	Time (year)
	Subsurface Soil	
Aluminum	0	10,000
Chromium	9.22E-53	10,000
Cobalt	0.646	961.3
Copper	1.46	9,539
Iron	241	2,055
Lead	7.54E-53	10,000
Lithium	0.000506	36.29
Manganese	9.46	2,566
Nickel	0.0429	6,081
Strontium	0.00000744	10,450
1,1-Dichloroethene	**0.0538**	**68.83**
1,2-Dichloroethene	**0.000664**	**20.75**
Carbon Tetrachloride	0.000185	307.2

Constituent	Property boundary Modeled Maximum Conc. or Activity (mg/L or pCi/L)	Time (year)
	Subsurface Soil	
PCBs	0	10,000
Pentachlorophenol	6.06E-19	12,910
Trichloroethene	**4.7**	**110.7**
Vinyl Chloride	**0.069**	**61.96**
Cesium-137	0	12,920
Neptunium-237	98.3	380.4
Plutonium-239	2.05	10,210
Radium-226	0.0216	9,765
Technetium-99	**13,200**	**112.7**
Thorium-230	1.3E-43	10,000
Uranium-234	894	5,140
Uranium-238	166	5,141
Total Uranium[a]	2,130	5,141

[a] Total uranium was analyzed as an activity for the WAG 3 Investigation and not as a concentration. MEPAS does not contain a provision for total uranium as activity in its chemical database, so total uranium activities were modeled as uranium-238.

2. Conceptual Model: SWMU 1

Source: *Remedial Investigation Report for Waste Area Group 27 at the PGDP* (DOE/OR/07-1777/V1&D2 June 1999)

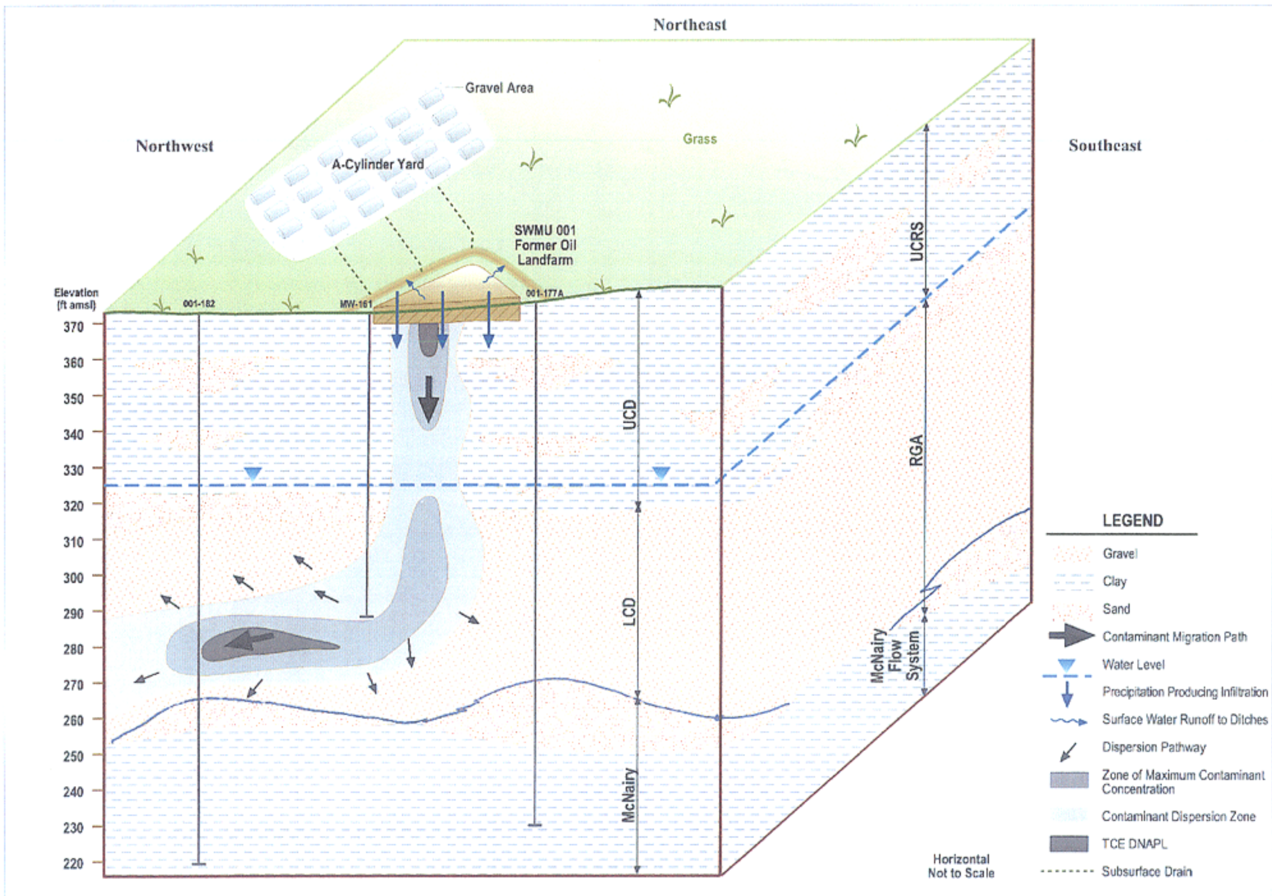

Fig. 4.9. SWMU 001 site conceptual model.

2. Conceptual Model: C-720

Source: *Remedial Investigation Report for Waste Area Group 27 at the PGDP* (DOE/OR/07-1777/V1&D2 June 1999)

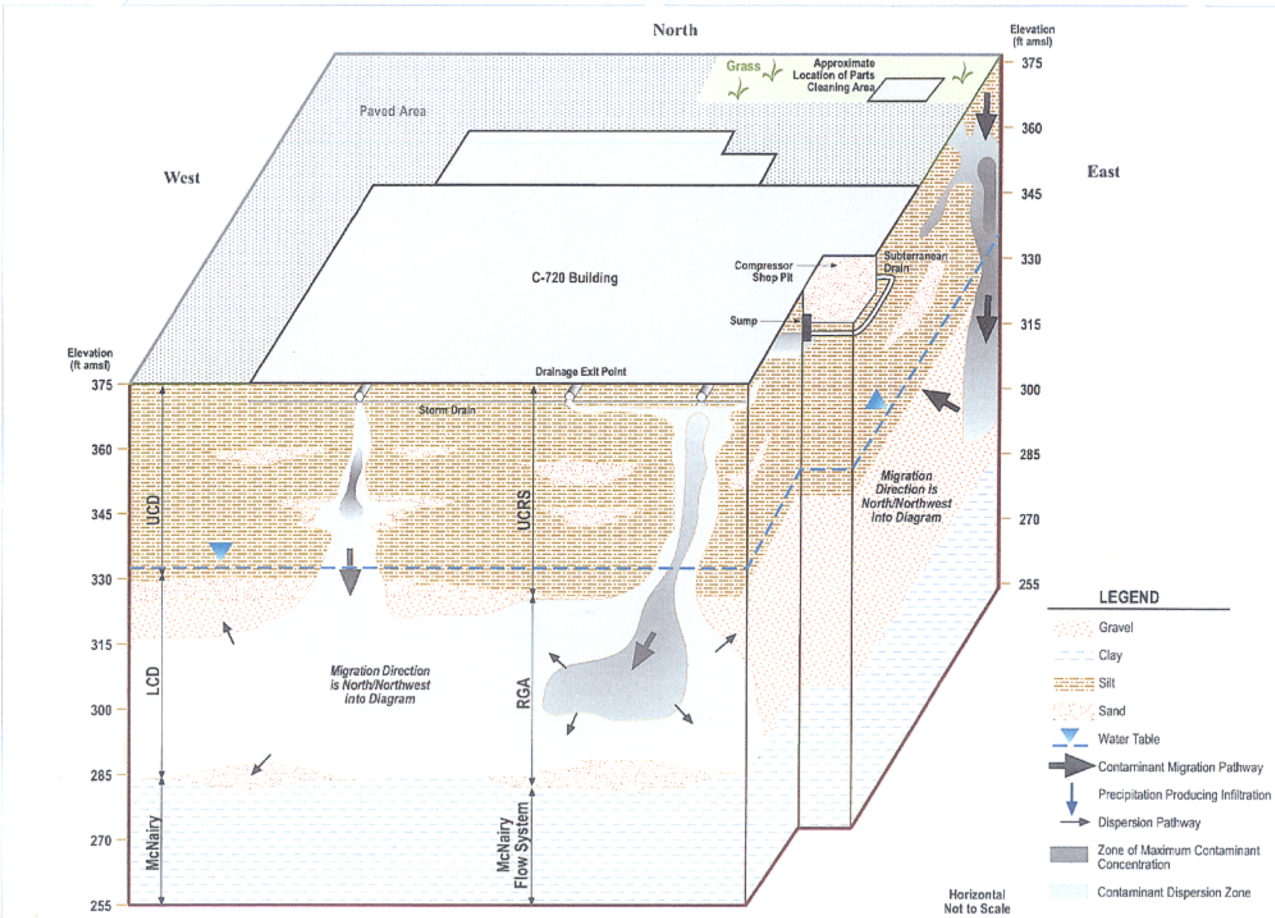

Fig. 4.28. C-720 site conceptual model.

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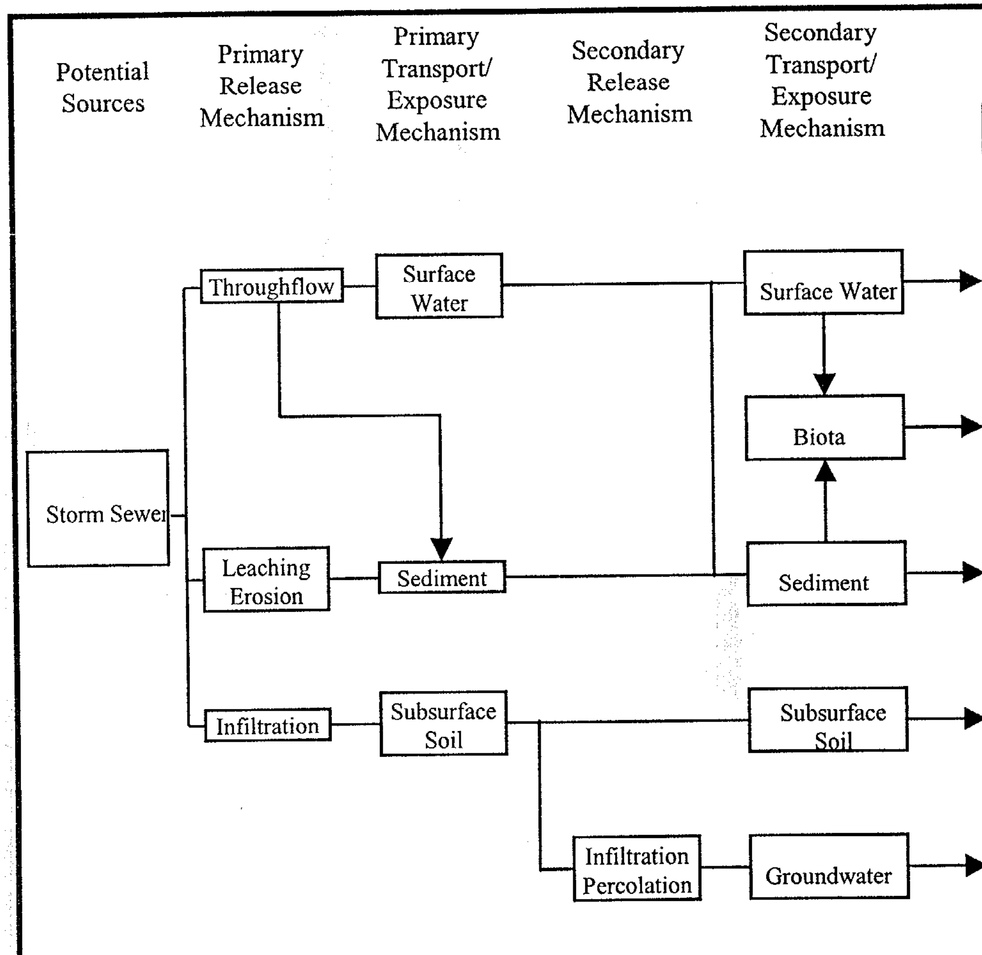
2. Conceptual Model: Storm Sewer

Source: *Surface Water Binning Packages presented to Core Team* (dated October 2000)



Potential Receptor and Exposure Routes/Pathways

Current Industrial Worker	Future Industrial Worker	Future Excavation Worker	Future Recreational User	Future Rural Resident
- Inhalation - Dermal - External Exposure	- Inhalation - Dermal - External Exposure		- Ingestion - Inhalation - Dermal - External Exposure	- Ingestion - Inhalation - Dermal - External Exposure
			- Ingestion of Game	- Ingestion of Agricultural Products
- Ingestion - Inhalation - Dermal - External Exposure	- Ingestion - Inhalation - Dermal - External Exposure	- Ingestion - Inhalation - Dermal - External Exposure	- Ingestion - Inhalation - Dermal - External Exposure	- Ingestion - Inhalation - Dermal - External Exposure
		- Ingestion - Inhalation - Dermal - External Exposure		
	- Ingestion - Inhalation - Dermal			- Ingestion - Inhalation - Dermal

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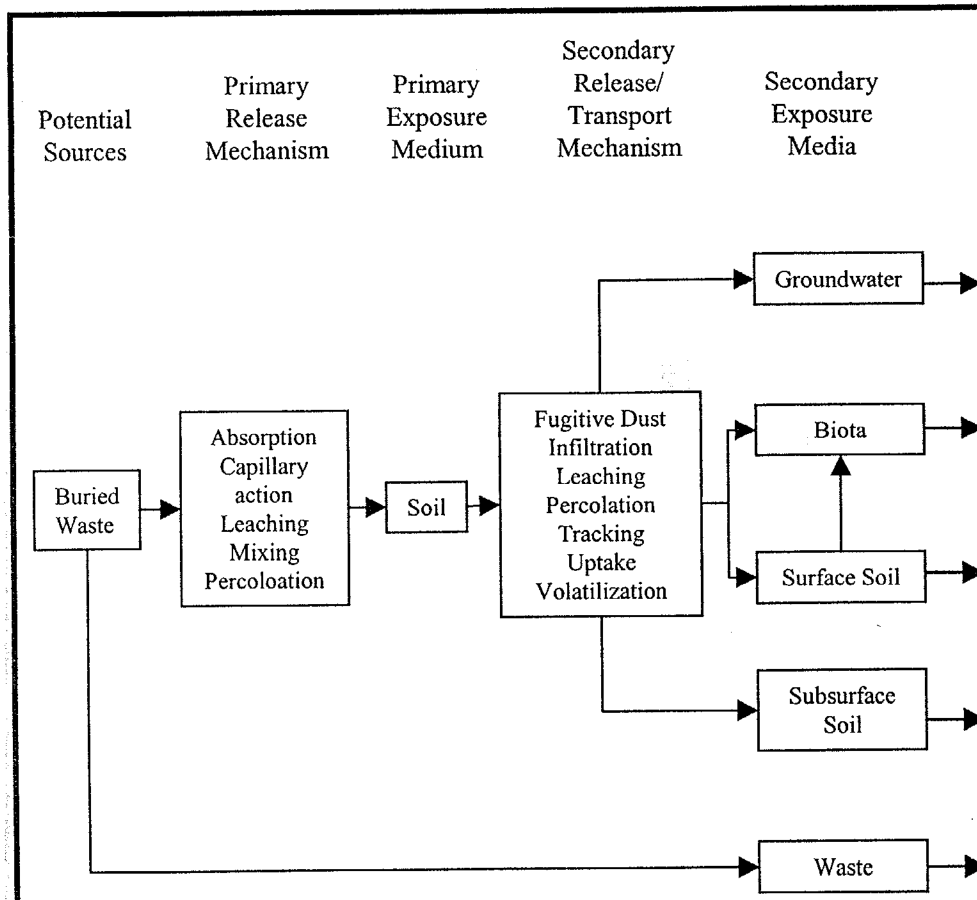
2. Conceptual Model: SWMU 4

Source: *Remedial Investigation Report for Waste Area Group 3 at the PGDP* (DOE/OR/07-1895/V4&D1 September 2000)



Potential Receptor and Exposure Routes/Pathways

	Current Industrial Worker	Future Industrial Worker	Future Excavation Worker	Future Recreational User	Future Rural Resident
Groundwater		- Ingestion - Dermal - Inhalation			- Ingestion - Dermal - Inhalation
Biota				- Ingestion	
Surface Soil	- Ingestion -Dermal - Inhalation - External Exposure	- Ingestion -Dermal - Inhalation - External Exposure	- Ingestion -Dermal - Inhalation - External Exposure		
Subsurface Soil			- Ingestion -Dermal - Inhalation - External Exposure		
Waste			- Ingestion -Dermal - Inhalation - External Exposure		

3. Likely Response Scenarios

- Primary Source Units (located in UCRS)
  - No action
  - Institutional controls (e.g., fencing, monitoring, etc.)

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  - Excavation and treatment/disposal
  - Extraction and treatment/disposal (e.g., soil vapor extraction, thermal heating technologies, etc.)
  - Containment (*in situ*; e.g., capping, etc.)
  - Treatment (*in situ*; e.g., solidification, vitrification, bioremediation, etc.)
  - Combination of actions

3. Likely Response Scenarios

- Secondary Sources (i.e., DNAPL located in RGA)
  - No action
  - Institutional controls (e.g., monitoring, etc.)
  - Extraction and treatment/disposal (e.g., pump & treat, thermal heating technologies, etc.)
  - Containment (*in situ*; e.g., solidification, soil mixing, slurry walls, etc.)
  - Treatment (*in situ,* either throughout the plume or downgradient at a treatment/reactive zone; e.g., oxidation, biodegradation, monitored natural attenuation, etc.)
  - Alternative Concentration Limits, Technical Impractability waivers, etc.
  - Combination of actions

3. Likely Response Scenarios

- Dissolved-Phase Groundwater Plumes
  - No action
  - Institutional controls (e.g., monitoring, etc.)
  - Extraction and treatment/disposal (e.g., pump & treat, thermal heating technologies, etc.)
  - Treatment (*in situ*, either throughout the plume or downgradient at a treatment/reactive zone; e.g., oxidation, biodegradation, permeable treatment zone, monitored natural attenuation, etc.)
  - Alternative Concentration Limits, Technical Impractability waivers, etc.
  - Combination of actions

4. Need for Data Collection and 5. Data to be Collected

SWMU 1

- Uncertainty
  - VOC (volatile organic compound) compositions and concentrations in the UCRS soils at SWMU 001 may have changed over time
- Discussion
  - WAG 27 Remedial Investigation data for SWMU 001 will be over six years old when SW Plume field investigation begins
  - Contaminants migrate vertically and laterally with time
  - Contaminants may break down to compounds with different risk values than originally modeled
- Resolution
  - Use direct push borings (DPT) with membrane interface probe (MIP) and discrete soil samples in nine borings to determine VOC nature and extent
    - One east-west transect of five DPTs through main area of contamination
    - One north-south transect of four DPTs through main area of contamination
    - Push DPTs to refusal depth, probably top of RGA (~ 60 feet)
  - Up to 35 discrete soil samples collected for lab analysis for VOCs from DPTs

4. Need for Data Collection and 5. Data to be Collected

SWMU 1

- Logic
  - Orientation and spacing of DPTs similar to that used in WAG 27
    - 50 feet between borings in east-west transect
    - 25 feet between borings in north-south transect
  - Borings spaced to sample between locations sampled in WAG 27
  - DPT method fast, relatively inexpensive, generates minimal waste
  - MIP provides continuous log of VOC concentrations versus depth
  - When coupled with gas chromatograph/mass spectrometer, MIP can also provide information on VOC species present in subsurface
  - MIP provides continuous log of soil moisture versus depth, aids in identifying silts and clays versus sands and gravels
  - Lab analysis of discrete depth soil samples allows direct comparison to WAG 27 data

4. Need for Data Collection and 5. Data to be Collected

C-720 Area (AOC 211)

- Uncertainty
  - There may be a source of TCE and/or ^{99}Tc contributing to groundwater contamination near the northeast corner of the C-720 Building
- Discussion
  - RGA groundwater data from the Phase IV and WAG 27 investigations suggest a TCE source area near the northeast corner of the C-720 Building
  - Two soil borings completed during the WAG 27 investigation in the area did not provide conclusive evidence of a source area
  - RGA monitoring well MW203 shows gradually increasing levels of both TCE and ^{99}Tc over the past eight to ten years
  - UCRS well MW204 has a history of both TCE and ^{99}Tc in shallow groundwater

4. Need for Data Collection and 5. Data to be Collected

C-720 Area (AOC 211)

- Resolution
  - Complete ten DPTs with MIP sampling in parking lot along and north of storm sewer running from west southwest to east northeast to street on east side of C-720
  - Collect up to 30 discrete soil samples for lab analysis of VOCs, metals, and radionuclides using MIP response curves as basis for selection of sample interval
  - Collect one round of groundwater samples from MW203, MW204, MW325, MW326, and MW330 for analysis for VOCs, metals, and radionuclides

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4. Need for Data Collection and 5. Data to be Collected

C-720 Area (AOC 211)

- Logic
  - Conceptual model for release is that equipment may have been degreased near north edge of parking lot prior to bringing into C-720 building for work
    - TCE used for degreasing was allowed to run onto parking lot and adjacent grassy area, consistent with operational practice at that time
    - TCE, possibly contaminated with ^{99}Tc, either soaked into the underlying soils or ran down the parking lot to the storm drain inlet on the west side of the parking lot
    - There may be sufficient TCE in the subsurface soils to provide a source of contamination to the RGA
  - Slope of parking lot and location of storm sewer suggest that TCE most likely would be located in northern portion of parking lot if conceptual model is correct
  - Since the MIP is responsive to VOCs, TCE concentrations sufficient to provide a source area to the RGA will be detectable by the MIP
  - If TCE were contaminated with ^{99}Tc, then intervals with increased levels of TCE are most likely to also contain increased levels of ^{99}Tc

4. Need for Data Collection and 5. Data to be Collected

SWMU 102 (Storm Sewer from C-400 to Outfall 008)

- Uncertainty
  - TCE and/or ^{99}Tc may have been transported by and leaked from the storm sewer between the C-400 building and KPDES Outfall 008 in sufficient quantity to be a source for the Southwest Plume
- Discussion
  - Data from the WAG 6 RI indicate shallow soil contamination associated with this storm sewer at the southwest corner of the C-400 Building
- Resolution
  - Use video camera to survey length of storm sewer (approximately 3000 feet) to confirm materials of construction, joint spacing and look for evidence of leakage
  - Use DPTs with MIP to sample bedding material along length of storm sewer to determine if TCE has leaked from storm sewer in sufficient quantity to be source to Southwest Plume
    - Up to 30 DPTs
    - Average depth of boring less than 20 feet

4. Need for Data Collection and 5. Data to be Collected

SWMU 102 (Storm Sewer from C-400 to Outfall 008)

- Resolution (continued)
  - If contamination is found in bedding material, push DPTs to refusal depth to determine extent of contamination
- Logic
  - Use video survey to determine boring locations
    - Areas of potential leakage first priority for DPT/MIP investigation
    - Pipe joints north of C-720 second priority, since plume appears to originate in this area
  - Use MIP to "sniff" bedding material immediately adjacent to storm sewer to ascertain presence of VOCs
  - If VOCs are detected, probe deeper and to sides to determine extent of contamination

4. Need for Data Collection and 5. Data to be Collected

SWMU 4

- Uncertainties
  - VOCs or ^{99}Tc may have migrated from the burial pits on the west side of SWMU 4 into the adjacent UCRS soils
  - The ^{99}Tc and VOC compositions and concentrations in the UCRS soils at SWMU 4 may have changed over time
  - SWMU 4 may be a significant source of TCE or ^{99}Tc to the Southwest Plume
- Discussion
  - WAG 3 RI data suggest burial pits on the west side of SWMU 4 have highest concentration of VOCs and ^{99}Tc of groundwater data collected at SWMU 4
  - Groundwater data from WAG 3 RI suggest SWMU 4 is a contributor to SW Plume
  - WAG 3 RI data for SWMU 4 will be five years old when SW Plume field investigation begins
  - Contaminants migrate vertically and laterally with time
  - VOCs may break down to compounds with different risk values than originally modeled

4. Need for Data Collection and 5. Data to be Collected

SWMU 4

- Resolution
  - Using WAG 3 surface geophysics data, survey and mark location of edge of burial pits on west side of SWMU 4
  - Complete ten DPTs with MIP sampling, 5 to 10 feet from side of burial pits
    - DPTs, spaced approximately 50 feet apart, placed west and northwest of SWMU 4
    - DPTs pushed to refusal - probably top of RGA at approximately 60 feet
  - Collect up to 30 UCRS soil samples for lab analysis of VOCs, metals, and radionuclides using MIP response curves as basis for interval to be sampled
  - Drill nine temporary RGA borings on east and west sides of SWMU 4 to collect up to 45 groundwater samples for lab analysis of VOCs, metals, and radionuclides
    - Four borings on east side of SWMU 4 represent upgradient conditions
    - Five borings on west side of SWMU 4 represent downgradient conditions
    - Final location of west side borings will be based on results from MIP results in DPTs
    - Groundwater samples to be collected from discrete depths from upper, middle, and lower RGA intervals

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4. Need for Data Collection and 5. Data to be Collected

SWMU 4

- Logic
  - WAG 3 data suggest that burial pits on west side of SWMU 4 contain high levels of VOCs and radiological contaminants (Maximum detects 67 mg/L TCE and 1640 pCi/L Tc-99)
  - WAG 3 data also suggest that contaminants have migrated from the pits to the surrounding soils and groundwater
  - DPTs with MIP sampling along west and northwest boundary of SWMU will provide data on vertical and lateral extent of contamination in UCRS to supplement data collected in WAG 3
  - Discrete soil samples will confirm VOC levels and provide ^{99}Tc data that MIP cannot detect
  - Groundwater data from RGA borings on east and west sides of SWMU 4 will establish current levels of contamination in RGA and contribution of SWMU 4 to overall contamination in Southwest Plume

4. Need for Data Collection and 5. Data to be Collected

SW Plume (dissolved-phase area)

- Uncertainty
  - The current levels and distributions of contamination within the Southwest Plume are unknown
- Discussion
  - MW161 is the only monitoring well within the main body of the plume that is routinely sampled
  - Other wells are either upgradient, on fringe of plume, or too shallow
  - Main data set is from temporary borings of WAG 27, WAG 3, and Data Gaps Investigation
    - WAG 27 data will be over six years old when this investigation begins
    - WAG 3 and Data Gaps data will be over five years old when this investigation begins

4. Need for Data Collection and 5. Data to be Collected

SW Plume (dissolved-phase area)

- Resolution
  - Drill and sample nine temporary RGA borings (in addition to temporary RGA borings scoped for SWMU 4)
    - Six borings just inside west plant security fence
    - Three borings immediately west of steam generation plant
  - Collect up to 45 discrete water samples for VOC, metals, and radionuclide analysis
- Logic
  - Borings along west fence to provide current picture of distribution and amount of contamination in the RGA
    - Use to update risk models
    - Use to plan possible dissolved-phase plume actions
  - Borings west of steam plant to determine if C-400 contamination is also contributing to Southwest Plume
    - Potential impact of C-400 actions on Southwest Plume
  - Use data to determine placement of up to three permanent monitoring wells to enhance monitoring of contaminant migration within plume

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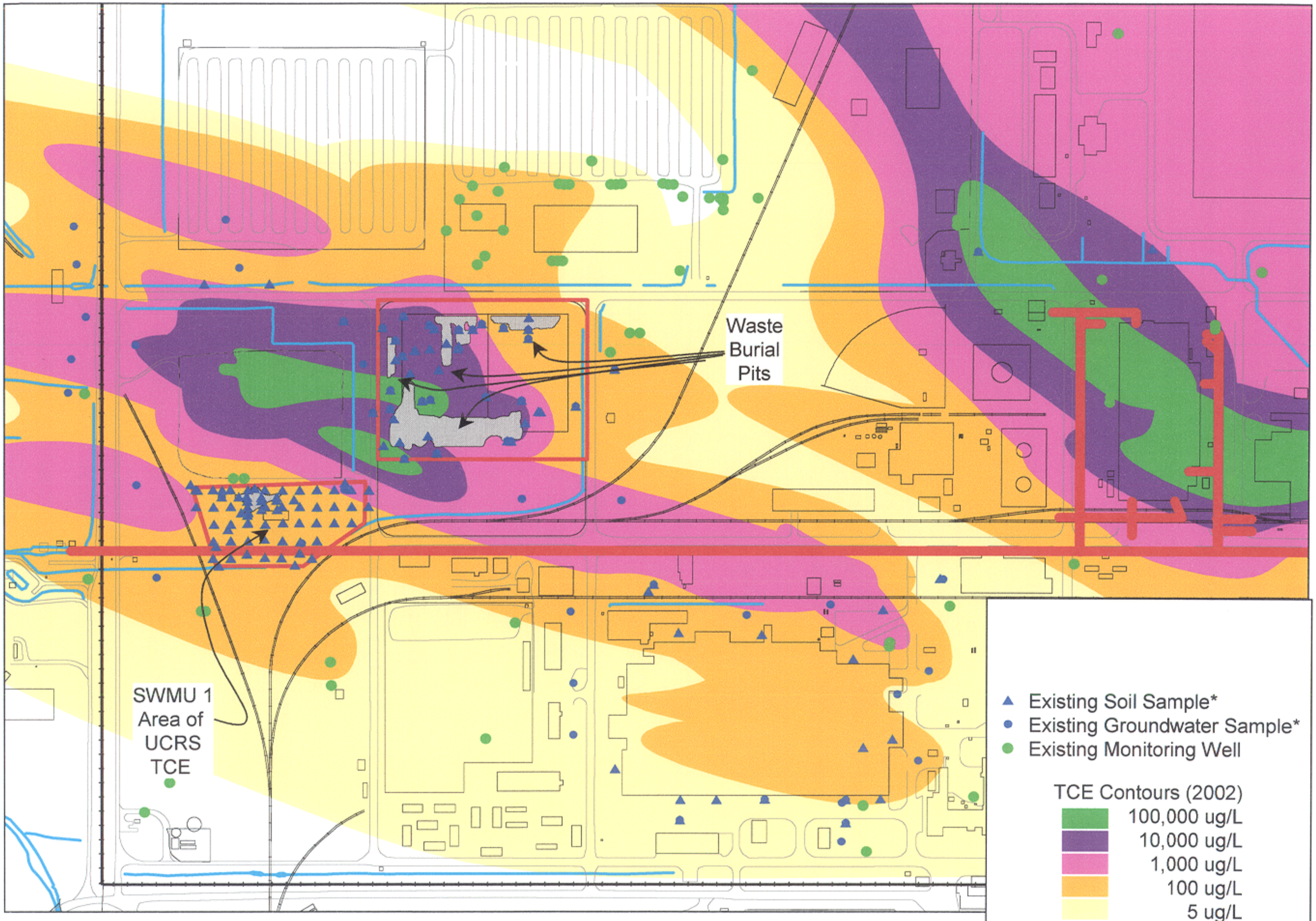
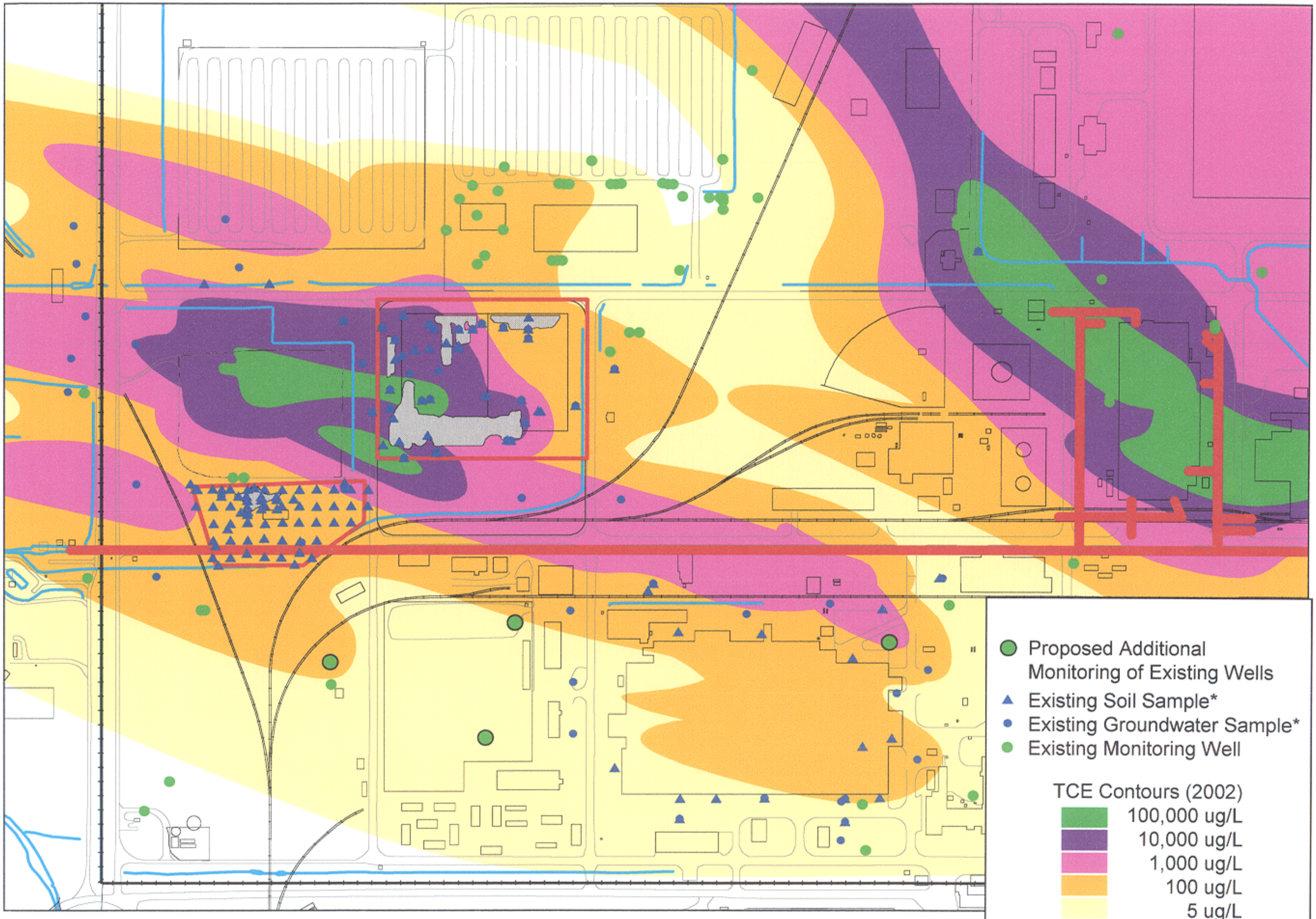
4. Need for Data Collection and 5. Data to be Collected

Quantitative Sampling Summary

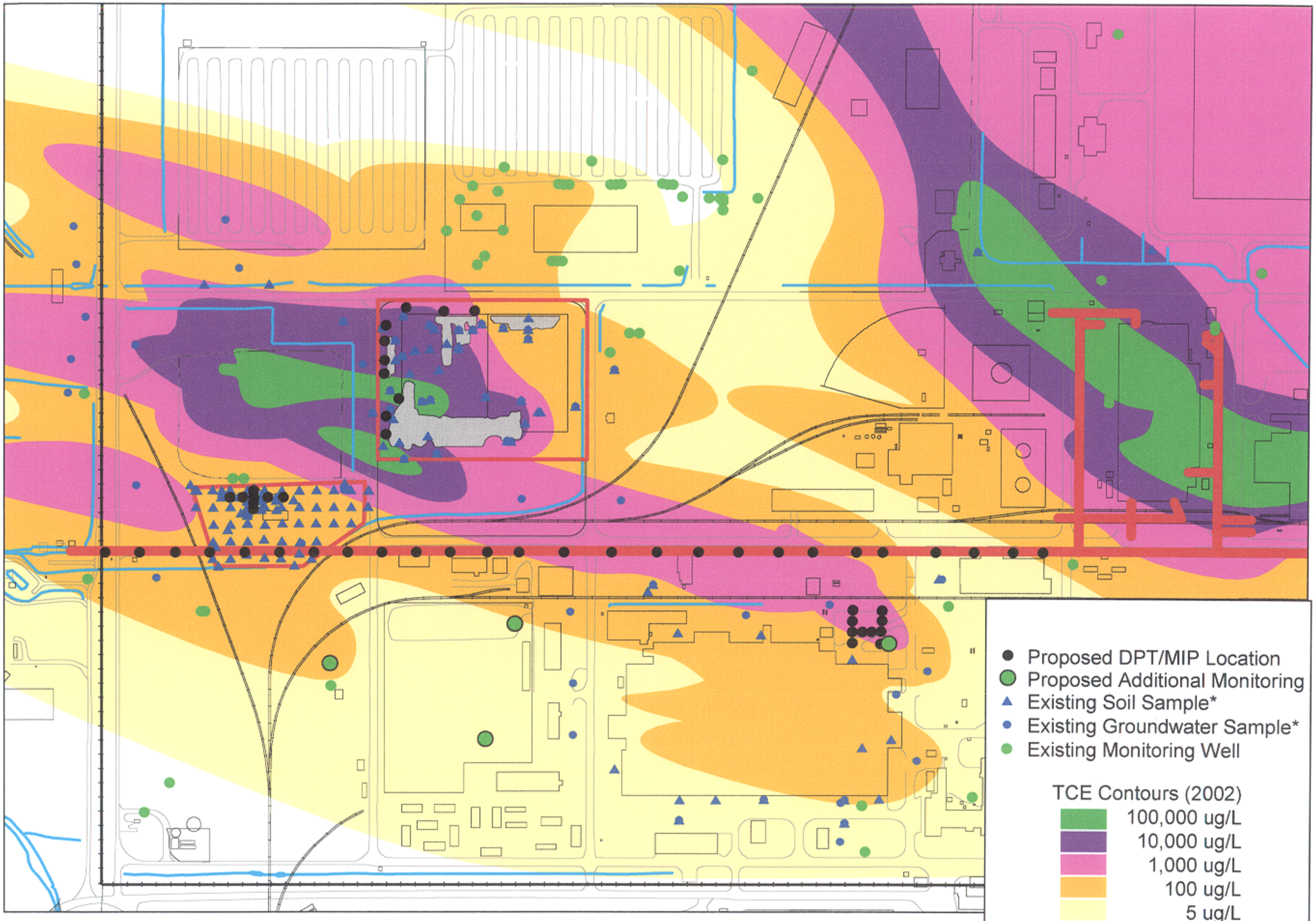
	UCRS					RGA					
	DPTs (with MIP)			Soil Samples		Temporary RGA Borings			Groundwater Samples		Other Sampling
	number	estimated depth	total footage	number	analyses	number	estimated depth	total footage	number	analyses	
SWMU 1	9	60	540	35	VOCs	-	-	-	-	-	-
C-720 Area	10	60	600	30	VOCs, metals, radionuclides	-	-	-	5	VOCs, metals, radionuclides	-
SWMU 102 (storm sewer)	30	20	600	-	-	-	-	-	-	-	Video Camera in Storm Sewer: 3000 linear feet
SWMU 4	10	60	600	30	VOCs, metals, radionuclides	9	100	900	45	VOCs, metals, radionuclides	-
SW Plume	-	-	-	-	-	9	100	900	45	VOCs, metals, radionuclides	Install up to 3 permanent monitoring wells
Totals	59	-	2,340	95	-	18	-	1,800	95	-	-



*Existing Soil and Groundwater Samples include data from the WAG 3, WAG 27, and Data Gaps investigations.
(Data from Phase I, Phase II, Phase IV, WAG 6, and WAG 23 investigations not included.)



*Existing Soil and Groundwater Samples include data from the WAG 3, WAG 27, and Data Gaps investigations.
(Data from Phase I, Phase II, Phase IV, WAG 6, and WAG 23 investigations not included.)



*Existing Soil and Groundwater Samples include data from the WAG 3, WAG 27, and Data Gaps investigations.
(Data from Phase I, Phase II, Phase IV, WAG 6, and WAG 23 investigations not included.)

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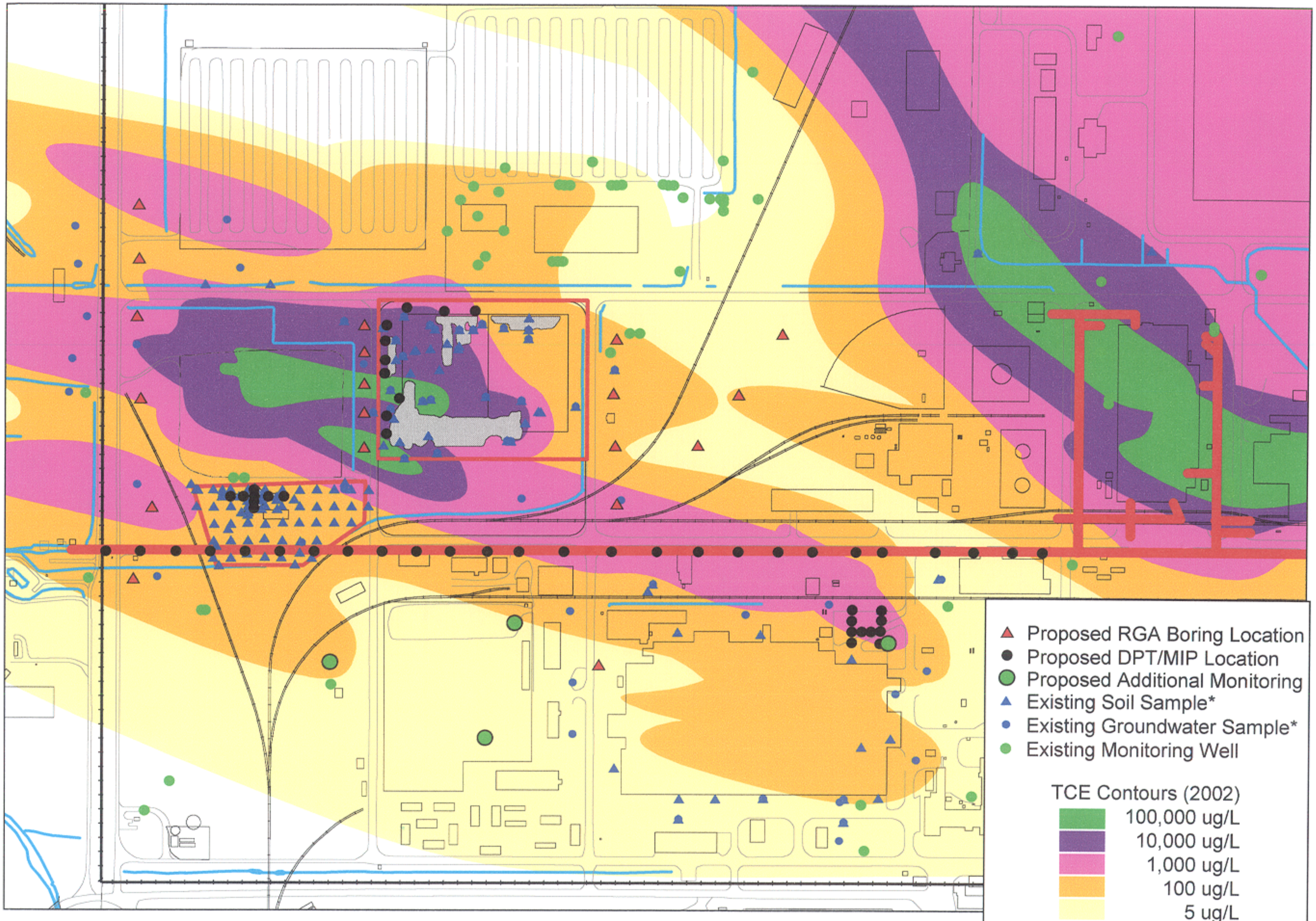

*Existing Soil and Groundwater Samples include data from the WAG 3, WAG 27, and Data Gaps investigations.
(Data from Phase I, Phase II, Phase IV, WAG 6, and WAG 23 investigations not included.)

6. Potential ARARs & TBCs

Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
		Potential Chemical-Specific ARARs	
National Primary Drinking Water Standards	40 CFR 141	Provides chemical-specific numeric standards for toxic pollutants expressed as MCLs and MCLGs.	These requirements are relevant and appropriate due to the nature of the contaminants found within the groundwater.
National Secondary Drinking Water Standards	40 CFR 143	Provides secondary MCLs for public water systems	These requirements are TBCs, as they have been established as guidelines for the states and are not federally enforceable.
Kentucky Surface Standards including • Warm Water Aquatic Habitat Criteria • Kentucky Domestic Water Supply • Kentucky General Standards • Kentucky Outstanding State Resource Waters	401 KAR 5:031 and 5:026	Provides chemical-specific numeric standards for pollutants discharged or found in surface waters. Provides chemical-specific numeric standards for pollutants in domestic water supplies.	These standards are applicable to the segment of the Ohio River into which the Little Bayou Creek discharges. The requirements found in these standards are applicable due to the groundwater to surface water interface to Little Bayou Creek and subsequently to the Ohio River. Note: Clean Water Act Water Quality Criteria are not relevant and appropriate because Kentucky has promulgated state standards that Kentucky has determined to be appropriate for waters of the State.
Radiation Exposure of the General Public at DOE Facilities	DOE Order 5400.5	Specifies that the general public must not receive an effective dose equivalent of >100 mrem/year from all exposure pathways. In addition, all release of radioactive materials resulting in doses to the general public must meet the ALARA criteria.	This requirement is TBC information.

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
CWA = Clean Water Act
DOE = U.S. Department of Energy
KAR = Kentucky Administrative Regulation
KPDES = Kentucky Pollutant Discharge Elimination System
MCLGs = maximum containment level goals
MCLs = maximum contaminant level
PGDP = Paducah Gaseous Diffusion Plant
TBC = to be considered

6. Potential ARARs & TBCs

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Standards, Requirement, Criteria, or Limitation	Citation	Description of Requirement	Comments
		Potential Location-Specific ARARs	
Protection of Wetlands	10 CFR Section 1022, Executive Order 11990 40 CFR 230.10 33 CFR 330.5	Activities must avoid or minimize impacts to wetlands to preserve and enhance their natural and beneficial value. If wetland resources are not avoided, measures must be taken to address ecologically sensitive areas and mitigate adverse effects. Such measures may include, minimum grading requirements, runoff controls, and design and construction considerations. Allows minor discharges of dredge and fill material, or other minor activities for which there are no practicable alternatives, provided that the pertinent requirements of the NWP system are met.	These requirements are applicable due to the presence of wetlands, but will be met though avoidance of wetlands during construction and implementation of alternatives.
Corrective Action beyond the Facility Boundary	40 CFR 264.101(c) 401 KAR 34:060 (11)	The owner or operator must implement corrective actions beyond the facility property boundary, where necessary to protect human health and the environment, unless the owner or operator demonstrates to the satisfaction of the Regional Administrator that, despite the owner's or operator's best efforts, the owner or operator was unable to obtain the necessary permission to undertake such actions. The owner/operator is not relieved of all responsibility to clean up a release that has migrated beyond the facility boundary where off-site access is denied. On-site measures to address such releases will be determined on a case-by-case basis. Assurances of financial responsibility for such corrective action must be provided.	These requirements are relevant and appropriate for facilities that have groundwater plumes extending beyond the property boundary.

ALARA = as low as reasonably achievable
ARAR = applicable or relevant and appropriate requirement
CFR = *Code of Federal Regulations*
CWA = Clean Water Act
DOE = U.S. Department of Energy
KAR = Kentucky Administrative Regulation
KPDES = Kentucky Pollutant Discharge Elimination System
MCLGs = maximum containment level goals
MCLs = maximum contaminant level
PGDP = Paducah Gaseous Diffusion Plant
TBC = to be considered

Summary

- VOCs (mainly TCE) and ^{99}Tc are the primary contaminants in the Southwest Plume
- Potential source areas will be investigated
- Investigation will be designed to identify sources/non-sources and support risk assessment, evaluation, and design of response action(s)

Path Forward

- Scoping Meeting 6/24/03
- D1 Sampling Plan 10/30/03
- Site Investigation Mobilization 3/29/04
- D1 Site Investigation/Risk Assessment Report 1/03/05
- D1 Proposed Plan 7/01/05
- D1 Record of Decision 1/03/06